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HUDSON BAY IN 1928: *A paper read at the Evening Meeting of the Society, 18 February 1929, by*

GEORGE BINNEY

IT is the custom of those who have the honour of addressing this Society to use a modest "we" in reference to their exploits. In this paper however modesty requires that I should use the term "I," not "we," for I am not speaking as the mouthpiece of the Hudson's Bay Company, which I am privileged to serve. It is true that I am here by their courtesy, but in a private capacity, as an observer who has watched conditions in Hudson Bay. If I relapse into the term "we," it will be from a subconscious dislike of the word "I," but at any rate it must not in your minds involve the Company's attitude towards any controversial points.

By virtue of the Charter granted by King Charles II on 2 May 1670 to "our dear and entirely beloved Cousin, Prince Rupert" and to that body of Royalists and merchants of London who were then named "The Governor and Company of Adventurers of England trading into Hudson's Bay" ships bearing the flag of the Company have for the last 260 years almost without interruption carried their annual burden of merchandise and provisions to the factories and forts situate at the mouths of the rivers of Hudson Bay; and it has been the privilege of the writer to partake in the latter three voyages along the coasts which abut upon Hudson Strait and Hudson Bay; to have assisted with hammer and with nails in the establishment of the most northern depôt on North Somerset Island in lat. 73° 49′; to have assisted with knife and with fork in devouring sturgeon at Rupert's House, the oldest fur trade post which lies at the southern end of James Bay; and to have assisted in performing a mastoid operation, this time with hammer and cold-chisel, at Okkak on the northern coast of Labrador. Such is life to-day in the service of the Company; after the heart of Hakluyt, champion of merchant adventurers.

In the good old days the Company's vessels sailed from Gravesend, and after touching at Stromness in the Orkneys, shaped their course boldly for the mouth of Hudson Strait. Nowadays they make for Montreal, where the bulk of the supplies for the Bay are loaded. They sail for the north during the second week in July with a full complement of fur traders and their wives, police and missionaries returning from furlough, together with apprentices

making their start in life in these far-flung outposts. The decks of the ship resemble a farmyard, crowded with cattle, sheep, pigs, horses, and chickens.

After touching at various points on the Labrador the vessel reaches the entrance to Hudson Strait during the last week of July, when as a rule the strait is free from heavy ice. The voyage up the Labrador (one should say down the Labrador to be correct) is usually calm during this period of the year; but fog is to be expected, and many a stately iceberg, drifting south from Baffin Bay, some afloat and others aground on the edge of the continental shelf. If the weather is foggy the siren is in continual use, not for fear of other shipping but in order to catch the echo from any icebergs which may be near.

After a voyage of about 1600 miles from Montreal, Cape Chidley, the most northern point of Labrador, is reached, 200 miles north of the coastal tree limit, and five degrees south of the Arctic circle. Twenty-five miles to the south-west of Cape Chidley, lying within Hudson Strait, is Port Burwell, the first port of call, where all ships bound for Baffin Island or Hudson Bay make their customs entry, a detachment of R.C.M. police being quartered at Burwell for this duty.

There is many a slip between the vicinity of Cape Chidley and Burwell Harbour. It frequently happens that heavy drift-ice is met at the entrance of the strait, even in the last week in July. If the ice is formidable, one does not attempt to make the Grey Strait between the Button Islands and Cape Chidley. The ice confined between the narrow limits of this " strait within a strait," and driven by the easterly current at 6 knots or more during certain stages of the tide, tends to raft, and it would go hard with the ship which attempted to force this passage—always bearing in mind the fact that fog is the second nature of that confluence of waters from Davis Strait in the north, Hudson Strait to the west, and the North Atlantic to the south and east. If conditions are unfavourable the captain gives a wide berth to the Button Islands, and working north towards Resolution Island he takes advantage of the westerly current from Davis Strait to gain the inside of Hudson Strait. There is less likelihood of heavy drift-ice at the end of July on the northern side of Hudson Strait, but experience has taught that under no circumstances whatever should a vessel attempt the passage into Hudson Strait between Resolution Island and Baffin Island; in this strait (the Gabriel Strait) the current and tides are exceptionally strong and lend colour to the assertion of Baffin Island Eskimo that icebergs are sucked down in the eddies and whirlpools of these troubled waters.

The ice encountered at the mouth of Hudson Strait in July has its origin partly in the heavy pack-ice of the shallow Fox Channel which lies to the north of Hudson Bay and separates the Gulf of Boothia from the west coast of Baffin Island, and partly in the Davis Strait pack. Fox Channel ice forming amid shoals and shallows is only released by the spring tides of the autumn, and, debouching into the western end of Hudson Strait, is carried by the current through the 500-mile-long Hudson Strait during the winter and spring, and only succeeds in reaching and being dispersed in the open waters of the Atlantic in June and July of the year following its release from Fox Channel. Fox Channel ice is of heavy calibre and can generally be distinguished by its

muddy hue from the equally heavy ice from Davis Strait, which is sometimes blown by north-easterly winds into the entrance of Hudson Strait.

Three seasons in Hudson Strait and a like number in the Spitsbergen Archipelago, and the privilege of many discussions with the masters of ice-going vessels, have convinced me that in no two consecutive seasons are local ice conditions alike (other than in the date of the break-up of river ice); but comparison of the records of to-day with those of thirty years ago shows that in general we are enjoying a period of amelioration. Whether this is a fluctuation governed by no laws, or whether there is a definite cycle of ice conditions dependent upon a climatic cycle, are problems of research beyond the scope of this paper.

"Ship-time" is the all-absorbing topic of a northern post. For 363 days it is discussed in every phase and from every angle by the fur traders, by the mounted police, the missionaries, and the natives. For the other two days it happens. At the end of it all nobody knows whether the arrival or the departure of the ship gives the greater satisfaction. For two days while the ship is in port the whole life of the station is topsy-turvy. The native families gather to the post in order to participate in the most exciting event of the year—the arrival of *their* ship, in which they have the greatest pride. No sooner are the anchors down than the ship is invaded by every soul who can be accommodated in the boats of the post; and those that cannot get a passage in the motor boats paddle out in their kayaks. It is difficult to conceive a more friendly, a happier, or a more excited community than swarms up the ship's ladder or the gangway, like children going to the pantomime. The greeting is threefold—*auktian-ai* (the Eskimo for cheer-o), the broadest of grins, and a handshake. On deck they are regaled with a banquet of bully beef and mugs of tea. They work with a will unloading the cargo—men, women, and children all lending a hand and a laugh.

Burwell Harbour owes its importance entirely to its geographical position at the entrance of the strait. It cannot claim to be a safe harbour; it is open to the south-west, the holding ground is poor, and its limits are confined. The main drawback is that it is not possible, owing to the proximity of the rocks, to put out sufficient anchor chain to safeguard a vessel from dragging in heavy weather. Two serious storms were encountered by vessels in Burwell Harbour in November 1927 and early in September of last year. In 1927 the steamer *Nascopie* faced a forty-eight-hour gale steaming against her anchors and unable to leave the harbour owing to the danger of collision with three Canadian Government vessels, one of which fouled the rocks and had to be beached. Last year the *Nascopie* and the *Ungava* faced an equally fierce gale, and were left no alternative but to make their best way out to sea in the inky darkness of the night, at times unable to make headway against the terrific force of the wind, and yet unable to heave-to owing to their proximity to land. In the second week of September 1926 we encountered a similar storm of hurricane force in Arctic Bay, a harbour within Admiralty Inlet, on the north-west coast of Baffin Island.

For the general traffic which may follow the completion of the Hudson Bay Railway nature has provided a harbour in the vicinity of the entrance of Hudson Strait—a haven where ships can lie in safety in the event of ice delay-

ing the passage through the strait, and where a coaling station can be established. One hundred and twenty miles south of Burwell on the northern coast of Labrador lies Hebron Harbour. The writer invited the opinion of Captain J. C. Jackson, who for thirty years has plied the northern waters of Labrador from Burwell to Makkovik, as master of the Moravian Mission vessel *Harmony*. He agreed that Burwell is a dangerous place, the harbour being so open to south-westerly winds, and so confined that you cannot give a vessel sufficient chain to lie with safety; for large grain ships the danger would be greater. With regard to harbours, Hebron is certainly the best; there is plenty of water, plenty of room, good holding ground; it is completely land-locked and it has practically no outlying dangers except Dog Island, which has a few reefs close in.

There are several harbours to the north of Hebron, such as Seglik, Ramah, Nachvak, Eclipse, and others, but none can compare with Hebron for accessibility, or safety when anchored. Such was Captain Jackson's opinion.

Proceeding westward from Port Burwell one crosses the broad mouth of Ungava Bay to the south. The shores of Ungava Bay and of Akpatok Island, which lies within it, have hardly been explored (let alone surveyed); into the head of the bay, 130 miles south of Hudson Strait, flows the Koksoak river, which drains the central plateau of Labrador. Twenty miles up the Koksoak river Fort Chimo is situated, a remote post established by the Hudson's Bay Company a hundred years ago as a centre for trade with the Nascopie Indians who range the interior of Labrador, and with the coastal Eskimo of Ungava Bay. With the assistance of a native pilot an ocean-going vessel can be navigated to the threshold of the post. The Koksoak river should only be entered at high water; the ebb tide runs at 6 knots, while the flood tide runs at 3 knots. Eddies and whirlpools are passed through, and, as might be expected, are worst at the numerous bends of the river which have to be negotiated. The swiftness of the current can be judged from a rise and fall of tide exceeding 30 feet. There are dangerous reefs and shoals off the mouth of the Koksoak river. Usually drift-ice remains in Ungava Bay after Hudson Strait is clear, and it is therefore customary not to visit Fort Chimo until the middle of August.

Akpatok Island stretches along the western shore of Ungava Bay from Cape Hopes Advance (the western limit of Ungava Bay) southward to Payne Bay. Very little is known of the island, other than that it is valuable to the Eskimo, who conduct a walrus hunt along its shore in the summer. Its limestone cliffs, about 500 feet high, are a remarkably good landmark in this featureless low-lying bay, and are reputed to contain fossil beds of great interest.

Steering a north-westerly course, a vessel bound for Hudson Bay keeps well to the centre of Hudson Strait to avoid the adverse current along its southern shores; on the northern side of this strait many icebergs are encountered—wandering from Baffin Bay. Halfway through Hudson Strait are two good harbours, Lake Harbour on the south coast of Baffin Island, and Wakeham Bay on the coast of Northern Quebec. The entrance to Lake Harbour can easily be distinguished on a clear day by the bold outline of Big Island, which is visible within a radius of 30 miles. The harbour lies within the belt of

Port Burwell

Hebron Harbour, Northern Labrador: Moravian Mission station in foreground

Lake Harbour Post in winter

Wolstenholme Post, northern Quebec

Pangnirtung Fjord, Cumberland Gulf, Baffin Island

Nastapoka Falls

rocky islands which fringes the south coast of Baffin Island and is completely land-locked. Here the Hudson's Bay Company maintain a coaling station. It is also the headquarters of the Company's schooner *Nanook*, which is manned and run entirely by an Eskimo crew, and which distributes supplies to Frobisher Bay and other Baffin Island posts where vessels of light draft are preferable. Wakeham Bay is also a well-protected harbour approximately 8 miles from the open sea, land-locked and surrounded by hills ranging from 500 to 1000 feet in height. This is another trading centre for Eskimo.

Proceeding yet farther westwards towards Hudson Bay one passes Amadjuak Harbour on the Baffin Island coast. According to Vol. 3 of the 'Arctic Pilot' (latest edition) "there is a perfect and easily accessible harbour at the head of Amadjuak Inlet." In point of fact the navigation is intricate, with unexpected shoals and rocks to circumvent. It is customary to retain an Eskimo to pilot the vessel to the post. The anchorage is good—when reached. In order to supplement the supply of caribou, so essential to the Eskimo both for winter clothing and food, the Company transported to Amadjuak in 1921 a herd of 600 domestic reindeer from Lapland together with several Lapp herders. Unfortunately the venture did not prove a success; but the herd, which scattered in search of food, has added considerably to the stock of wild caribou, and it would appear that the reindeer and the wild caribou have intermingled, judging from the account of the natives.

A forty-four-hour passage from Port Burwell brings us to the western extremity of Hudson Strait, where Nottingham Island, Salisbury Island, and Mill Island are the stepping-stones from Cape Wolstenholme on the southern side of the Strait to Cape Dorset on the south-west extremity of Baffin Island. The Hudson's Bay Company operates posts at both these points. There is a good harbour at Dorset, but Eric Cove, the harbour of Wolstenholme Post, has no protection from the north, and while it is bounded to the east and west by high cliffs, the configuration of the hills is such that in whatever direction the wind may blow it swoops down through Eric Cove. Wolstenholme is a bye-word for its winds, as Burwell is for its fogs—but whoever heard tell of a respectable strait which did not veil its nakedness in fog and dispute with boisterous winds the right of way ?

Hudson Strait has two features of comfort to navigators: it is broad and deep. Its average width is 50 miles, while its depth at the Atlantic entrance is 340 fathoms, and at the Hudson Bay end 130 fathoms. In the event of thick weather the cautious master is loath to slow his ship down for fear of the swift cross currents and tide, on which he has no check and which may land him on the rocks.

In the summer of 1928 the Canadian Government took an important step towards the improvement of the shipping route by the establishment of three wireless stations in Hudson Strait, at the Button Islands, at Cape Hopes Advance, and on Nottingham Island, for the local purpose of providing directional bearings and ice reports for ships navigating the straits in thick weather, and for the equally important and far-reaching purpose of providing a meteorological service. These stations were established by Major McLean, of the Department of Railways and Canals, in charge of the Hudson Strait Flying Expedition (1927–1928), which successfully conducted ice reconnais-

sance in Hudson Strait during the autumn and winter of 1927 and the spring and summer of 1928. Thus to a large measure the dangers of navigation have been mitigated, there now being a check on compass and on course, fog or no fog. The danger from collision with icebergs is not so great as might be imagined if the three precautions are taken, a vigilant outlook, the blast of the ship's siren which echoes on the face of tabular bergs, and the feel of the air. Icebergs are not encountered west of Charles Island. Hudson Bay is also free of this menace to shipping, there being no passage for them from the north down the shallow Fox Channel.

The south coast of Baffin Island is uniform in its rugged features, being indented with countless inlets hidden away behind a belt of islands and rocks, in this respect resembling the coast of Labrador, though lacking its comparative fertility. The coastal mountains, which are of no great height, stretch back into the interior to a distance of 40 or 50 miles, where they give way to tundra land. At the south-east corner of Baffin Island, in the fjords of Cumberland Sound, the mountains and cliffs are of a much bolder stamp, resembling (so far as can be judged from photographs) the towering grandeur of Scoresby Sound on the east coast of Greenland. With the exception of the Grinnell Glacier in Frobisher Bay, which descends from a local ice-cap, and with the exception of a few small glaciers which descend into Navy Board Inlet on the north coast of Baffin Island, the great ice-cap which once enveloped this barren land has entirely vanished. This disappearance, rapid when compared with the conditions of the Greenland ice-cap in the same latitude, is due to the low elevation of Baffin Island and therefore to its higher mean temperatures.

On the south side of Hudson Strait and to the west of the low-lying Ungava Bay the coast-line is bold and clean-cut, there being no fringe of islands and comparatively few inlets of any depth. The cliffs and hills range between 400 feet and 1300 feet in height, and form narrow valleys and coves very difficult to distinguish from one another. The coastal belt of hills extends 40 miles inland, and is succeeded by an undulating plain.

No continuous survey of Hudson Strait has been conducted as yet. The configuration of the coast-line has been filled in from disjointed observations and from hurried sketches; there has also been recourse to poetic licence. The fact is that Hudson Strait has never appealed to the explorer as a suitable field for detailed survey, the task being purely utilitarian and lacking the spectacular element of work in higher latitudes. Not only is Hudson Bay gourd-shaped, but the condition of its cartography lends itself to the old metaphor of the unwisdom of placing new wine into old gourds, for it would be better to start *ab initio* with a proper survey than to attempt to recondition this unserviceable container of the Bay waters with a patchwork of corrected positions and redistributed islands.

From north to south Hudson Bay stretches to a length of 800 miles; its maximum width is about 500 miles. To the south it narrows into the shallow *cul-de-sac* of James Bay. Thus the influence of the Fox Channel and of Hudson Strait are challenged by no warm currents from the south other than the many rivers which drain the 1,500,000 square miles of Rupert's Land. Thus, in spite of its moderate latitude and of the luxuriant vegetation of its

southerly coasts, Hudson Bay retains an Arctic character though it cuts the same parallels as England and Scotland; and owing to the prevailing north winds which drive and shepherd the ice southward, the farther south one ventures into the bay the more ice one meets. The average depth of this inland sea is about 80 fathoms, though James Bay is exceptionally shallow and is navigated with great caution and with constant use of the lead.

At no time of the year is Hudson Bay entirely frozen over; a broad belt of coastal ice forms along the shores, but the central waters are ice-free (apart from drift-ice) as is the case in Hudson Strait. On the other hand, James Bay, shallow and brackish from the waters of the great rivers which flow into it, is usually frozen across by the month of February. Apart from the shore-ice and from the lighter floes of river ice which are fed into the bay at the break-up, it sometimes happens that the heavy Fox Channel ice from the north escapes its usual channel of egress through the Hudson Strait to the Atlantic, and debouches into Hudson Bay under the influence of heavy northerly gales. This was probably the case during the late autumn of 1927; for no Fox Channel ice was reported in Hudson Strait by the Canadian Government station on Nottingham Island; yet last summer (July 31 to August 3) on the voyage from Wolstenholme to Charlton Island, we encountered an exceptionally heavy ice-field from the latitude of Port Harrison southwards for a distance of over 300 miles and stretching beyond the horizon from east to west. At times we could make no headway through it in spite of the strength and build of our 2000-ton vessel, constructed for ice navigation. Much of the ice was discoloured and of heavy texture, reaching to a depth of 15 feet or more. In places there was evidence of rafting at some period of its existence. One always expects to meet drift-ice off the mouth of James Bay, particularly off the south-western coast of the Bay between York Factory and Cape Henrietta Maria (the north-western extremity of James Bay), but so extensive and so heavy a field was an unexpected hindrance. On the voyage north from Charlton Island to Fort Churchill (August 13 to 19) we again encountered this ice-field, though looser and easier to navigate, to within 60 miles of our destination. I ought to explain that vessels employed on the Hudson Bay trade route (*i.e.* from Fort Churchill to the Atlantic) would have been clear of this ice-field.

Ice usually forms in the harbours of Hudson Bay towards the last week of October; there ensues an interregnum of about a month when it is possible to travel neither by boat nor by sledge. By the first week in December the rivers are well frozen. The break-up of the rivers is in May or in early June. Broadly speaking, the northern half of the main Hudson Bay waters is open to navigation from the early part of July, by which time the drift-ice will have been swept to southward. In James Bay the coasting schooners are in commission during the last days of June, dodging from post to post in the open channel of water between the coast-line and bay ice which is pivoted round the islands and shallows in the centre.

In final reference to ice conditions in Hudson Bay it should be stated that once a vessel has safely negotiated Hudson Strait, there should be a clear run as far south as Fort Churchill without difficulty or danger from ice. The Strait is the stumbling-block; the Bay is the broad highway.

The features of the coast are singularly uninspiring, and lend nothing to the romance of life in Hudson Bay. The protagonists are the men—not the mountains. The east coast which borders the vast Quebec–Labrador Peninsula alternates between cliffs and hills, rarely attaining a height of 2000 feet, and low-lying land gradually rising to a belt of mountainous country some 10 miles inland. The coastal waters are foul with reefs, and south of Cape Smith the waters are studded with a chain of countless small islands extending to the southern limit of James Bay. Protected by these islands is an inner "run" of service to small schooners, and to natives who ply their canoes along this coast. Some 70 miles off the coast a chain of larger islands stretches to the mouth of James Bay; these have been roughly grouped from north to south as the Ottawa Islands, the Two Brothers, the Sleepers, King George Islands, Baker's Dozen, the Belcher Islands. Gilmour Island is the most conspicuous of the Ottawa group, rising to a height of 1800 feet (Mount Allan). Captain John Murray, present master of the S.S. *Nascopie*, reports a fine sheltered harbour on this island, used by the Dundee whalers who caught bowheads in these waters in the early spring and the late autumn. Captain T. F. Smellie, who has long experience in the Bay, reports that the Ottawa Islands are charted 10 miles too far to the westward; that the Two Brothers in the latitude of Cape Dufferin do not exist; that an island exists in the latitude of Cape Dufferin but 20 miles to the west of the charted position of the western Two Brothers; in James Bay the North and South Twins are charted 8 miles too far to the westward.

Probably the most conspicuous and interesting feature of Hudson Bay lies halfway down the east coast, a region visited by very few white men other than fur traders. Here the Nastapoka river flows over the cliffs and forms a great waterfall within a quarter of a mile of the Nastapoka Sound. The falls are about 160 feet high and 60 feet across the top and descend into a narrow gorge. The spray on a calm day rises to about twice the height of the falls. The aspect is to the west, and the river from the falls to the sea is only about a quarter of a mile long and is quite deep. All the other rivers in the Nastapoka Sound have falls in them, but they are more in the nature of a series of steps, the coast-line here being high and dipping sharply into the sea. For the account of the Naspoka Falls I am indebted to Chief Trader S. J. Stewart, the Hudson's Bay Company's post manager at Port Harrison, who on several occasions has visited these falls in the course of his coastal journeys. The coastal tree limit is in the vicinity of Richmond Gulf, but the Eskimo trade 100 miles farther south to Great Whale River Post, which is the northern limit of the Indian trade.

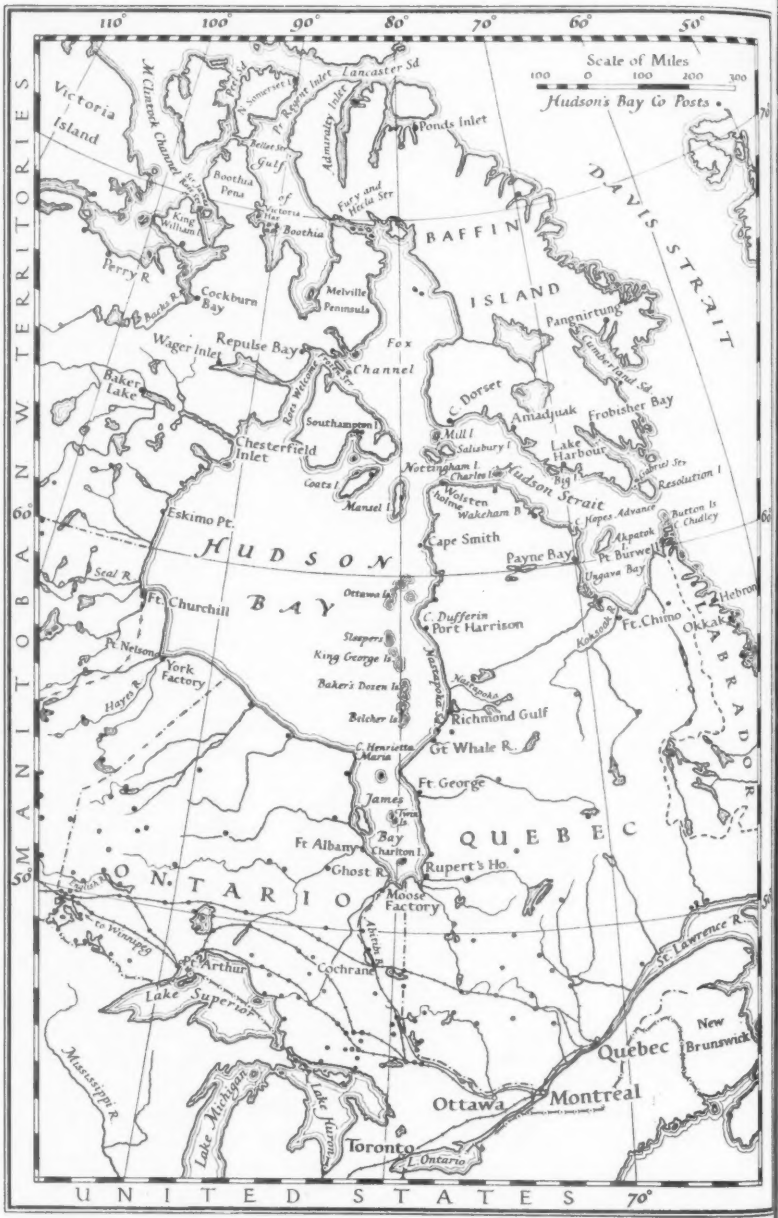
The only striking characteristic of the James Bay coast-line is the general flatness of the land, with the exception of Mount Sherrick, which acts as a fine landmark for Rupert's House lying in the extreme south-east corner of James Bay. These waters are exceptionally shallow, and although one may be out of sight of land it is possible to touch the bottom with the oar of a rowing-boat. At low tide there are mud flats from end to end of the coast. The vegetation is luxuriant, heavy timber lining the foreshore. So marked is the contrast between the vegetation in Hudson Strait and James Bay, that we refer (in lighter vein) to James Bay as the "Banana Belt."

The west coast of Hudson Bay from Cape Henrietta Maria in the south to Eskimo Point, some 500 miles to the north, is flat, but clean-cut and in marked contrast to the island-studded shores of the east coast. The coastal waters are very shallow, and with the exception of York Roads and Churchill Harbour are inaccessible to ocean-going vessels. North of Eskimo Point the character of the coast changes; it is indented with numerous inlets and the inshore waters are dotted with a belt of rocks, islands, and reefs. Northward from York Factory the coastal tree zone is left behind, though the inland tree limit reaches the latitude of Eskimo Point. From Eskimo Point the Barren Lands extend northwards to the Polar Sea on the northern coast of Canada. For the most part they consist of rolling tundra interspersed with rocky ridges.

The northern boundary of Hudson Bay consists mainly of the large low-lying triangular expanse of Southampton Island and of Coats Island and Mansell Island. Southampton Island, which is separated from the western shore of the mainland by the channel known as Sir Thomas Roes Welcome and from the southern extremity of the Melville Peninsula by the Frozen Strait, faces to the north-east for 190 miles the southern opening of the Fox Channel. Mansell Island is approximately 65 miles in length and 15 miles broad, low-lying and of limestone structure. The northern end of Coats Island is highland: Captain Smellie reports that Cape Pembroke, the north-eastern point, is charted 10 miles too far north.

The old sea phrase that "a passage perilous makyth a port pleasant" cannot aptly be applied to a vessel emerging from Hudson Strait to Hudson Bay; for, with the exception of Port Harrison on the east coast of the Bay, there are no known natural harbours suitable for large vessels throughout the length and breadth of the east coast. In the southern half of the Bay and in James Bay one would hardly expect to find harbours, as the coastal waters are so shallow and the mouths of the rivers are silted with mud and sand. For instance, Fort Albany in James Bay is only accessible to schooners drawing 8 feet of water during spring tides; and no post can be reached except on the high tide. At Charlton Island facing the main channel of James Bay the whole outfit for the James Bay district is landed from the supply vessel in August for distribution by schooner. Port Harrison affords the best protection to a vessel which has to winter in these waters, as in this harbour it is less exposed to the danger of damage from river ice at the break-up in the spring. For all we know there are good harbours in the Ottawa Islands or the Belcher Islands for ocean-going vessels.

On the west coast Fort Churchill, established in 1700, has come into prominence as the terminus of the Hudson Bay Railway, which is to be completed in 1930–1931. In the old days before the trans-continental railways and the Panama Canal altered the complexion of fur trade transport routes, the headquarters of the Hudson's Bay Company were at York Factory, 120 miles south of Fort Churchill; for, lying at the mouth of the Hayes river, it was the distributing centre of supplies shipped from London to the far-flung outposts of Western Canada. In those days the waters of the Hayes river resounded to the songs of the *voyageurs* and to the rhythm of many paddles as the fur brigades set out over the network of the rivers and lakes to the Winnipeg basin, to the Mackenzie river, and to the Rockies. To York Factory came the



Sketch-map to illustrate Mr. Binney's paper: Hudson Bay in 1928

first ship of emigrants under Lord Selkirk's scheme of colonizing the middle west of Canada in the early nineteenth century. These were the men and women who formed the first Red River settlement in 1812—the founders of Winnipeg.

In those days of bitter rivalry between the fur traders of Montreal and the Hudson's Bay Company, the possession of Hudson Bay constituted a distinct advantage in the all-important problem of transport routes. For whereas the fur traders of Montreal had to send their fur brigades as best they might from east to west by the river and lake route, with innumerable portages and rapids to circumvent, the Company's supplies were landed on the threshold of the west, either at the mouth of the Hayes river or of the Churchill river. Whether you are a fur trader carrying your supplies to the hinterland or whether you are a farmer exporting your wheat from the hinterland to the markets of the world, one fundamental economic law prevails—carry your produce by the high seas to the last mile; it is much less costly than land transport. For many years this has been the cry of the farmer in Manitoba and Saskatchewan faced with the equally long train haul of his wheat either to the Atlantic or to the Pacific coast.

When the Hudson Bay route was first contemplated many years ago, Port Nelson, in the vicinity of York Factory, was its destination, but with the revival of the project Fort Churchill has been selected as the terminus of the railway after the advice of leading harbour experts has been taken. Within a mile and a half from its mouth, the broad and swift-flowing Churchill river narrows to a width of 800 yards and flows into Hudson Bay between the limits of a rocky shore. The mouth of the river faces north and is fairly well protected from the open sea by the outlying points of land.

There are, of course, engineering problems such as one would expect in transforming the mouth of the Churchill river into a modern port; therefore it is not to be wondered that while the railway will reach Fort Churchill in the autumn of 1929, it is unlikely that the harbour works will be finally completed before 1931. A comparison of the mileage of the present trans-Canada grain route from Saskatoon to Liverpool via the Great Lakes, with the mileage of the new trade route via Hudson Bay is in itself sufficient reason to justify so costly an undertaking as the building of a railway, the making of a port and the establishment of lighthouses and wireless stations along the route.

Mileage of Present Trans-Canada Grain Route from Saskatoon to Liverpool.

Saskatoon—Port Arthur (by rail)	1142 miles
Port Arthur—Liverpool (by lake steamer and ocean steamer)	4071 ,,
Total mileage of route ..	5213 ,,

Mileage of Hudson Bay Grain Route.

Saskatoon—Fort Churchill (by rail)	845 miles
Fort Churchill—Liverpool (by ocean steamer) ..	2946 ,,
Total mileage of route ..	3791 ,,

By employing the Hudson Bay grain route the following savings are

effected: (1) 297 miles of rail transport; (2) 1125 miles of ocean transport; (3) the elimination of trans-shipment costs of grain from lake steamers to ocean steamers.

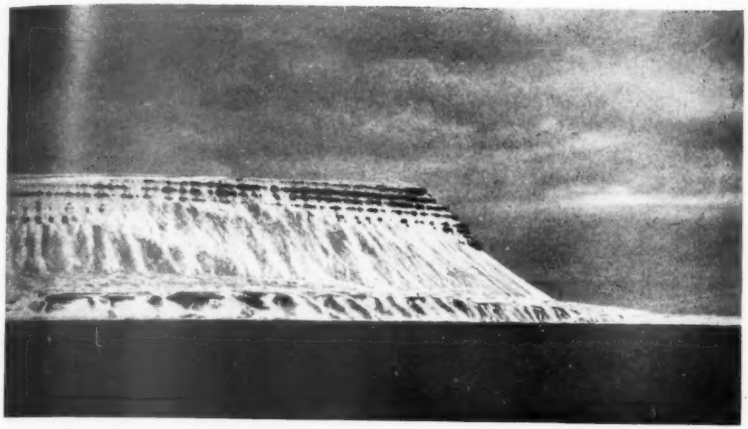
I do not propose to deal at length with the vexed question of the period of the year during which the new trade route is likely to be navigable. During August, September, and October in the great majority of years the route would be entirely free from ice, and likewise during November I would not anticipate the likelihood of serious ice, though I would be prepared for very heavy weather, particularly at the Atlantic entrance to Hudson Strait. There is in my opinion good reason for optimism as to the value of this new route for the trade both of the Canadian Middle West and of England.

One cannot but pause to consider the effect of civilization upon the Eskimo and Indians who inhabit those regions.

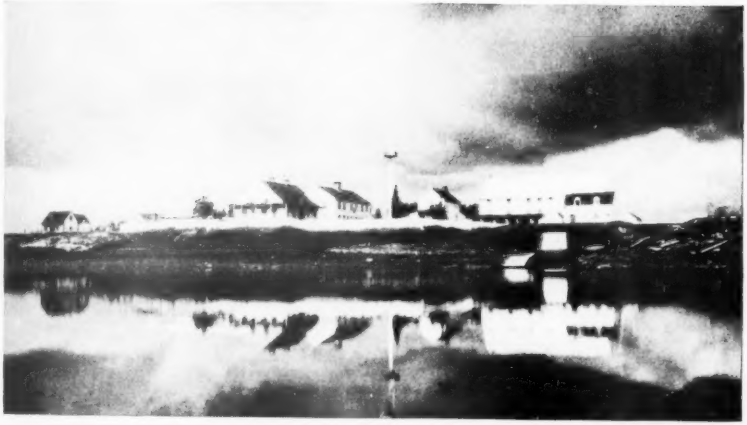
In the old days before the native traded with the white man, if he did not hunt he starved. Consequently, on the principle of the survival of the fittest, stock was virile. As a matter of common history, it has been the Company's policy to encourage the natives to remain on their hunting grounds and thus to protect them from those elements of civilization likely to be injurious. The contact of civilization with primitive races resembles the contact of radium with the human body. If skilfully applied it can be of the greatest benefit. If applied unskilfully it may destroy that which it is intended to benefit. In those old days protective measures were easy, for it was unnecessary to provide anything but the simplest wants, such as knives, needles, molasses, traps, flint-locks, and blankets. But with the advent of the modern rifle, the motor boat, etc., very useful adjuncts to races which have grown up with the evolution of these things, great problems have arisen. For these things tend to induce ease: ease is the first cousin of indolence: indolence is akin to disease. The native used the kayak: now he can sit back in his motor-boat and reach his journey's end without effort. In the old days he hunted with his spear: now he uses the rifle, gaining his meat with less effort, and often destroying more life than is necessary. The rifle tends to frighten the caribou and the seal from their usual haunts and to diminish their numbers. And so increasingly he is demanding white man's food, less rich in vitamin than the food which nature provided for him.

Overshadowing these general influences of civilization on primitive people is the natural problem of fur cycles. What happens to a native in a year when fur is scarce? What happens in this country when an industry passes through a difficult time? Unless the greatest care and foresight are used, the workers have to be supported by the Government, and then subconsciously they tend to lose their self-reliance when they eat food which they have not earned by the sweat of their brow. The same laws hold good in the north; therefore in the non-trapping season of the year every endeavour is made to provide work, so that, come what may with their traps, there is some form of employment to ward off indolence and to safeguard the self-respect of the worker.

A survey of the advance of civilization on Hudson Bay would be incomplete without reference to the partial building of a railway from Cochrane towards the head of James Bay. The line has reached a point some 80 miles south of



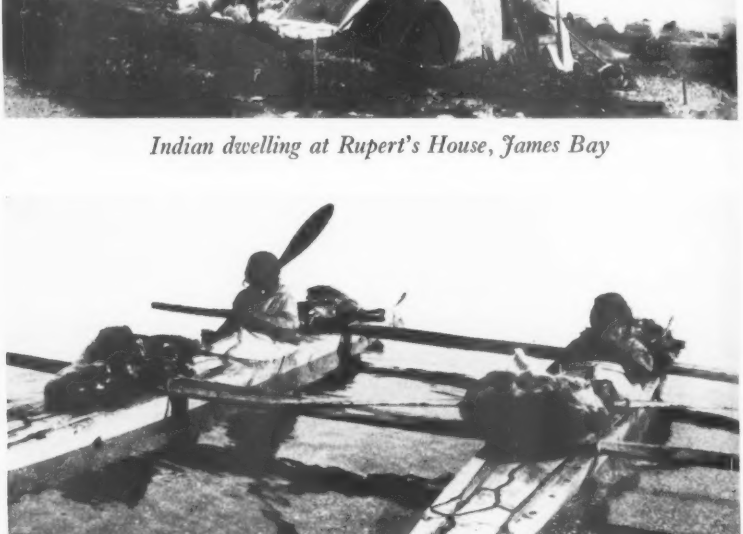
Port Leopold, North Somerset Island



Moose Factory, James Bay

Nascopie Indians at Fort Chimo

Indian dwelling at Rupert's House, James Bay



Caribou-skin kayaks used by Baker Lake Eskimo

After a white-whale drive in Cumberland Sound, Baffin Island

Moose Factory, its ultimate destination; but it would seem that this railway is designed more with a view to opening up the timber and mineral wealth of the country through which it passes, than as an export route via James Bay, where ocean-going vessels cannot approach the land. From rail-head to Moose Factory is a two-and-a-half days' journey down the Abitibi river, but owing to the long portages the route is not practical for freight. The Revillon fur trading company operate a river route from a small depôt on the Canadian National Railway down English river and Ghost river to Fort Albany in James Bay. Freight is floated downstream in scows; but the route is only practical immediately after the break-up, when the rivers are high. In years when the snowfall has been exceptionally meagre the route is unnavigable even for shallow-draught scows.

Commanding the entrance to Churchill Harbour and opposite to the harbour works and to the construction camp lies the massive ruin of Fort Prince of Wales, a stone-built fortress constructed by the Hudson's Bay Company in 1742 to protect their trade against the rivalry of the French.

The problem of Indian and Eskimo welfare diverges once the fundamental factors of ease and disease have been stated. For the Indian of the woods and lakes differs very widely in character and in mode of life from the Eskimo of the Barren Lands. The one is subtle under the deep shadow of his forests; the other is clear-cut in the open spaces of the tundra.

Three different types of Indians are encountered in Hudson Strait and Hudson Bay. The hunting grounds of the shrill-voiced Nascopie Indians lie in the interior of the Labrador–Quebec Peninsula: they pay an annual trade visit to Fort Chimo at the southern end of Ungava Bay. The southern half of Hudson Bay from Great Whale River on the east coast to York Factory on the west coast is the coastal limit of the Swampy Cree Indians. A fairly large percentage of them are coastal—that is to say, they live and trap along the coastline within the vicinity of the posts. But the majority of them have their trapping grounds inland and only visit the main trading posts of the Bay during the spring and summer. A small band of Chipewyan Indians has its headquarters at Fort Churchill during the summer, but with the advent of the railway the Indian Department is considering the advisability of moving them farther afield from the influences of civilization.

It is very difficult for the white man to gain an insight into the character of the Indian. As a trader he is shrewd and as a trapper he is far more expert than the Eskimo. Except in those regions where the white trapper has penetrated and has played havoc with the stock of fur-bearing animals, the Indian carefully conserves the fur, realizing that his livelihood is at stake if the beaver or musk-rat colonies are over-trapped. In intellect he is aloof and not easily influenced; quick-witted and mercurial. Each Indian band has its chief, who rules with the aid of his councillors. The Indian keeps his wife and daughters very much in the background. At those posts where the Indians and Eskimo both trade it is noticeable how little they intermingle. The Indian looks down on the Eskimo; in the very rare cases of inter-marriage the parties are ostracized by their respective tribes.

The inland Indian being a forest dweller suffers less from the rigour of the Canadian winter than the Eskimo of the Barren Lands, and consequently

summer or winter he lives in his tepee, protecting himself from the cold with sleeping-robes plaited from thin strips of rabbit-skins. Where there are permanent Indian settlements (particularly among the coastal Indians of the Bay and among those Indians who are in closer contact with civilization), the habit of living in shacks has superseded their natural tepee life—with disastrous results to health. These shacks, dirty, over-heated, and with no proper ventilation, actively contribute towards ill health and are a hotbed of infection between the ailing and the healthy who overcrowd their narrow limits.

If the Indians are more fortunate than the Eskimo in having at all times a plentiful supply of fuel and the forest shelter from extreme temperatures and winds, their lot is harder when it comes to food supplies. The inland Indians are dependent partly on the flour,* molasses, lard, tea and sugar which they trade in exchange for their furs, and partly on the fish, deer, rabbits, and other game which are yielded by their trapping grounds. The Indian often traps 300 miles away from the post where he trades, and he can therefore only carry limited supplies with him in view of the many portages which obstruct the water routes. Very largely, therefore, he has to rely on his own resources, his women folk snaring rabbits and catching fish while he attends to his traplines. Neither rabbits nor fish are a body-building diet, and consequently in years when deer or moose are scarce his powers of resistance are impaired by lack of nourishment. Furthermore, in order to provide sustenance for his family, he is forced to kill more beaver than he would otherwise take, thus depleting unduly the beaver colonies, upon which a portion of his livelihood depends.

There is nothing new in this problem of food scarcity among the inland Indians. Among wild animals there are years of moderate supply and years of abundance, followed by years of scarcity merging once more into moderate supply, which form a natural cycle. For example, there is a marked ten-years' cycle among wolves. Nature provided the caribou and, to a certain extent, the bush rabbit as the natural food of the wolf. When wolves are in great abundance they kill off the caribou, so that in the following years the wolves themselves are starving for lack of food, and either die from starvation itself or from disease caused by starvation. Then follows a period when there are few wolves to prey on the caribou, with the natural result that the caribou increase in number; correspondingly the wolves increase until once more they decimate the caribou and in their turn dwindle from lack of food. From very earliest years the Indian has faced and has survived these years of scarcity, so that he is innured to hardship and to periods of malnutrition.

The diet of a coastal Indian presents a different problem. Although he lives on the coast he is not a sea hunter like the Eskimo, and while he fishes and shoots duck and geese, he does not hunt the sea mammals which provide rich food in plenty. This is partly due to his inability to sew clothes suitable for hunting on the floe-ice in the winter and partly due to the Indian's innate fear of the sea and to his dislike of seal or whale flesh and blubber. Therefore to a very large extent he depends upon white man's food, ekeing out a pre-

*In order to safeguard his flour from damage, before starting on his inland journey the Indian dips his sacks in water, so that a hard and impermeable crust protects the flour within.

carious living by trapping along the coast in the winter, and in places where the soil permits, such as near Rupert's House and Moose Factory, cultivating small crops of potatoes in the summer.

There is one universal menace to all primitive races in contact with civilization—tuberculosis, though it appears to be less pronounced in Hudson Bay than in other parts of Canada, where there has been closer contact with civilization. During the winter when the climate is dry the natives show marked powers of recuperation, but in the spring of the year when mocassins provide little protection from the damp of thawing snow, when everything is damp, then is the time of sickness; then is the time of infection, which is sterilized during the cold of the winter. The only serious epidemic among the Indians of Hudson Bay is the periodic outbreak of influenza, but the mortality among them is less alarming than among the Eskimo, possibly because their long contact with civilization has partially inoculated them.

There are very few Indians indeed who do not profess a Christian belief, and who do not contribute either in work or in a tithe of their fur towards the expenses of their mission.

The Eskimo referred to in this paper are usually known as the "Central" Eskimo to distinguish them from the Greenlanders to the east and from the Eskimo of Alaska and the Western Arctic to the west. The Central Eskimo range from Hopedale, on the Labrador coast, northwards along the coast-line of Hudson Strait, and along the eastern shores of Hudson Bay to Fort George, at the mouth of James Bay.

Fort George and its neighbouring post, Great Whale River, are important in Eskimo history in that Eskimo literature, which so far is confined almost entirely to religious books, has been written in the dialect prevailing at these posts. The books have spread to all parts of the Central Eskimo territory with the exception of the Labrador, and consequently this dialect is likely to become the standard dialect of the language. Whereas the Labrador Eskimo have been taught to read Roman characters and through the influence of the Moravian Missionaries have assimilated into their language a number of German and English words, the other Central Eskimo have been taught to read Syllabic characters, an ingenious system of hieroglyphs invented by a missionary in the early part of the nineteenth century; the Syllabic is the purer of the two written dialects.

On the west coast of Hudson Bay the most southerly of the Central Eskimos had their headquarters at Fort Churchill, but they have now moved 40 miles farther north to Seal river. This tribe ranges up the western coast beyond Eskimo Point. They are known as the Padlimiuts; their hunting grounds are within the tree-zone, and while they spend the spring and early part of the summer hunting seal and walrus along the coast, they are primarily an inland tribe depending for their livelihood more on caribou than on seals. It is a curious fact that, in marked contrast to the open countenances of the Barren Land Eskimo, the Padlimuits who dwell on the fringe of the forest country have in their features the reflection of Indian craft and subtlety.

North of the Padlimuits dwell the Kinipitumuits, who trade at Chesterfield Inlet. They are of the caribou culture as contrasted with the seal culture of

the maritime Eskimo of Hudson Bay and Strait. Ranging north from Chesterfield to Repulse Bay, at the southern end of the Melville Peninsula, are the Aivilliks, who in days gone by formed the crews of the whaling vessels and have retained their sea-calling. Inland to the north-west of the Kinipitus and the Aivilliks live the Nechelliks, who are of the caribou culture and cover their kayaks with deerskin instead of sealskin. The north-western limits of their trapping grounds extend to Backs river and the Arctic coast of the mainland. In this region there are many smaller tribes, but as they rarely visit the trading posts of Hudson Bay they fall beyond the province of this paper.

Southampton Island, lying to the east of the coast-line between Chesterfield Inlet and Repulse Bay, is of great ethnological interest in that the strange Sagdlingmuit tribe existed here until the winter of 1902, when all save two small children perished from some virulent epidemic or food-poisoning. These people, who lived in stone houses and were unable to travel in the winter owing to their inability to build snow-houses, are reputed to have been the last of the Tunits, the "different" people who lived in the north and who, failing to adapt themselves to the primary methods of existence, dwindled until they finally disappeared. I know of only one living man who was in contact with them—Captain John Murray, master of the S.S. *Nascopie*. On more than one occasion he wintered on Southampton Island with his Aivillik whaling crew, and visited the Sagdlingmuits in their stone houses. They were covered with soot and grime from the smoke of their lamps; presumably, as they lived in stone houses they suffered from the cold far more than the snow-house dwellers, and consequently found it necessary to make excessive use of their seal-oil lamps. They spoke a dialect differing from the Aivilliks, with whom they had but little intercourse. It has frequently been stated that the Sagdlingmuits died from starvation. This is not the case; Captain Murray states that when they were found dead there was a plentiful store of walrus meat in the encampment.

Southampton Island is now inhabited by a colony of Aivilliks and Baffin Islanders, who do not mingle with one another. The Hudson's Bay Company has brought natives alternately to Mansel Island and Coats Island from the south coast of Hudson Strait, in order that the trapping grounds of the mainland should not be depleted unduly. But for fear of the extermination of caribou on these comparatively small islands these posts have now been closed down.

It is not necessary to describe in detail the various tribes which as a people form the Baffin Islanders. The most remote are the Igluliks, who border the west coast of Baffin Island facing Fox Channel. Sometimes they cross Fury and Hecla Strait to trade at Repulse Bay; other years they journey to Ponds Inlet on the northern coast of Baffin Island with their furs and their ivory. There are colonies of Baffin Islanders grouped around the entire coast-line. They are essentially seal-hunters and, while they hunt the caribou in the autumn for the warm winter clothing which it provides, first and last the seal is their emblem.

For sheer zest of living, for care-free disposition, and for friendly spirit it would be difficult to match the Eskimo character. There could hardly be two greater contrasts than the Indian and the Eskimo: the one aloof, lithe in

intellect, a guardian of forest secrets; the other responsive, simple, and of open countenance.

Between the Eskimo and the white man there are many chords of sympathy, for underlying their laughter and devil-may-care attitude lies a standard of honesty, good faith, and sportsmanship unequalled in any civilized race. Likewise in the affection which they bestow on their families and in the friendliness which they show towards their neighbours, they are a generous example to the white races. They are by nature improvident and careless, the latter defect resulting in many gun accidents in the north. They make splendid mechanics, and where a white mechanic would be held up by the lack of spare parts and the necessary tools, the Eskimo will go to work with infinite patience and fashion a new part from some piece of waste metal with the aid of a small file. The new part, when completed, will be the equal in every respect of the broken one.

It is only on very rare occasions indeed that an Eskimo resorts to violence. The few crimes which have been committed in the north have been due either to fear, in which case the crime is premeditated against the man feared, or else to sudden unreasoning frenzy which results in running amok, and the Hudson's Bay Company are proud of the fact that with one exception there have been no instances of violence against the Company: that exception was in the Western Arctic where one of the Company's managers was shot dead when going to the assistance of a mounted policeman who had just been shot by the same Eskimo.

The Eskimo, did they but know it, have a distinct advantage as compared with the Indians. You cannot stop an Indian from cutting down trees and building himself a shack; but as there is no timber in the north the Eskimo is dependent upon the white man for building material. Any one who has had the opportunity of comparing the conditions of the Labrador Eskimo, who live in shacks throughout the year, with the condition of the Hudson Bay and the Hudson Strait Eskimo, who live in tents during the summer and snow-houses during the winter, will bear out the assertion that from the standpoint of native health it is highly undesirable to introduce houses into the north. The native occupation is hunting and trapping: in both cases it is a nomad existence from one hunting ground to another. If you accustom the native to live in a house or shack he loses the hunter's spirit, which is the life-blood of his race. Equally important, he loses his health. In the spring, summer, and autumn, the Eskimo live either in sealskin or caribou-skin tents, or in canvas tents which are lighter and cleaner; in the winter they build their snow-houses, which give such wonderful protection against the cold. Tents and snow-houses have the great hygienic advantage of not being permanent establishments, and they are therefore less likely to harbour the germs of disease. On the other hand, tent life has its unsatisfactory features; for winter sets in before there is sufficient snow for the building of snow-houses, and likewise in the spring the igloos melt long before the snow is off the ground. During these two transitional periods tent life in the one case is extremely cold and in the other is extremely wet. The exposure and the dampness thus encountered are allies of tuberculosis; but their threat is as nothing compared with the menace with wooden shacks. In the vicinity of Baker Lake some of

the natives adopt a unique practice in order to obtain the shelter of an igloo before the snow lies sufficiently deep. They cut out blocks of ice and build a temporary igloo with them, filling in the crevices with snow.

It is idle to compare the housing conditions of the Greenlander and the Canadian Eskimo; for the Greenlander is of hybrid race and is civilized, whereas the Central Eskimo still remains almost pure aboriginal stock. While the one requires permanent housing by reason of his civilized outlook, the other has no need of it and would lose his vitality, not having in him the Greenlander's white element to respond to civilized standards.

On the Labrador coast to-day one sees an Eskimo race of comparatively pure stock after a century and a half of domestication or devolution—call it what you will. The natives have gone downhill under the influence of shack-life, and are now a feeble, feckless people lacking the fibre of the Eskimo of Hudson Bay and Baffin Island—a reminder that in the eighteenth and nineteenth centuries there was no scientific study of the effect of civilization on primitive people, either among Governments, explorers, missionaries or fur traders. The Moravian Missionaries recently invited the Company to establish trading posts at all their stations on the Labrador coast, so that there should be a combined effort to improve the condition of the people by gradually freeing them from those elements of civilization which have added the "d" to "evolution."

As yet there are no chronic problems connected with Eskimo food supplies, though at the Labrador posts, in Ungava Bay and on the east coast of Hudson Bay, it is necessary to provide a fair quantity of food, as by excessive slaughter in the past the Eskimo have diminished the stock of caribou or alternatively have frightened the caribou far inland beyond the distance which the natives will travel in their autumn deer hunt. While flour is not injurious in itself, it lacks nourishment, and when used as a substitute for stronger foods leads to malnutrition, which is a favourable breeding ground for tuberculosis.

In Ungava Bay and along the south coast of Hudson Strait comparatively few seals are taken. Again the excessive use of the rifle must be blamed; for the seal has learned to give a wide berth to the regions surrounding a post. Another drawback of the use of a rifle is that when seals are shot in the water they frequently sink before they can be gaffed, and are therefore lost. We reckon that one seal in every three shot in the water is lost: therefore the native is encouraged to net seals in preference to shooting them. The seal is by far the most vital item in the native diet, for seal flesh is richer in vitamin-content than any other meat; nor should it be forgotten that sealskins provide both summer clothing and skin boots universally worn in the north, and that seal blubber provides fuel both for light and heating.

In July and August salmon, sea trout, and codfish are caught on the northern parts of Labrador. The Atlantic salmon is also found in Ungava Bay, but, as far as I know, does not appear farther west in Hudson Strait or Hudson Bay, though the rivers team with trout. In the more southerly reaches of Hudson Bay a species of herring is caught in the river estuaries; and in the inland river waters sturgeon, white fish, and pickerel are netted by the Indians. In Baffin Island Arctic char (*Salmo nivalis*) are netted in fair quantities in August.

Fish play an important part in the economy of the north, providing food

for the whole community, including the dogs; but the best dog-food of all is walrus meat. Walrus are killed as far south as James Bay. When walrus meat is fed to the dogs, the inch-thick hide is left on the meat so that there is plenty to chew. The natives themselves are also fond of this meat.

Of the other mammals the most common is the white whale, a species of porpoise (*beluga*) which is found along all the coast of Hudson Bay and Hudson Strait and is usually netted in the river estuaries and in the sheltered bays. The white gelatinous substance which forms the outer coating of the hide (known as *muktuk* to the natives) is regarded as a great delicacy. In the most northern waters of Hudson Bay, around the mouth of Fox Channel and off the north coast of Baffin Island, the narwhal is hunted. It is of the porpoise tribe, but is easily distinguished by the long tusk (up to 8 feet in length) which protrudes from the head of the male. The tusk is used for digging clams, mussels, and other food off the sea-bed. In value it is very similar to the white whale, providing the so-called porpoise hide from which boot-laces are made, and food for both men and dogs. The Right or Greenland whale, which originally brought the Dundee and the American whalers to Hudson Bay, has of recent years reappeared in these waters, but not in sufficient quantity to justify a revival of the industry.

From the mouth of James Bay northwards the polar bear is hunted and is the source of the greatest excitement among the Eskimo and their dogs. While the husky-dogs are frightened of wolves and will not eat their flesh, if they get the wind of a bear (*nanook*) they are after him like greased lightning and impede his escape until the arrival of the hunters.

All the larger birds, including gulls, divers, geese, eider-duck, and ptarmigan, are eaten by the natives; in the spring of the year expeditions are made to the outer islands where the duck nest and the eggs are collected. Those which are not eaten immediately are buried in the earth for use later in the year. There is no such thing as a bad egg to an Eskimo palate or nostril, and putrid meat or fish are not repugnant to them and appear to cause no ill effects. I have heard the theory advanced that, like the dog, the Eskimo has a greater supply of hydrochloric acid in his system to counteract the possible infection of putrid food.

During the spring and summer months it is the general practice among the Eskimo to make caches of meat (protected by rocks) for use in the following winter. These meat caches have a triple purpose: they serve either as dog-food or human food, and they also attract the foxes by the smell of food to the vicinity of the trapping grounds. Often, too, in the autumn, a whale or a walrus carcase is dragged up on the foreshore to provide the foxes with meat lest they should migrate for want of food to other regions. Eventually, when the time is ripe, the natives set their traps round these carcases.

From this account of the food supplies of the shores of Hudson Bay it might be supposed that there was meat in abundance, but it must be borne in mind that the native is improvident, and that through his habit of killing every creature at sight animal life is scarcer and is evolving a wary instinct.

The Central Eskimo number approximately 3500 all told, and (as with the Indians) there is a tendency towards close inter-marriage, difficult to check in view of their being spread out for the most part in small and isolated bands;

but as the Eskimo brings his troubles and his aspirations to the post manager, it sometimes falls to the latter's lot to guide the native's choice of a bride, when such has seemed a proper course.

The Eskimo are menaced by the same dread disease (tuberculosis) as the Indians, but to a lesser extent; for with the exception of Labrador, where tuberculosis has a hold, the people are hardy and for the most part healthy, but such sickness as exists among them is lung trouble or some other tubercular affection. As is the case with the Indians, the Eskimo are healthiest during the winter months and succumb to illness in the spring, when tent life gives inadequate protection against the damp. In the early summer, when they are living largely on a fish diet, it is not uncommon for them to contract a skin affection which in appearance resembles small-pox, but which soon passes away, leaving no marks or after-effects.

In the autumn of 1918 a third of the Eskimo population of Labrador was wiped away by a virulent form of influenza. In that year the other Central Eskimo were fortunately not affected, but in the summer and autumn of 1928 there appears to have been an influenza pandemic throughout the north of Canada from the delta of the Mackenzie river to Frobisher Bay on the south-east coast of Baffin Island, resulting in heavy mortality among the natives. The Labrador was also smitten with it, but although there were many serious cases of pneumonic-influenza, yet there was not a single death. It seems as if the people have been innoculated against the virus by their contact with it ten years ago. Until an influenza serum has been discovered there appears to be no means of protecting the Eskimo from this fatal infection. At the Hudson's Bay Company's posts a complete medical outfit is provided for the benefit of all and sundry, and the post managers perform such medical and surgical work as lies within their power. A medical officer accompanies the vessels in the summer; all the sick are brought to the post for examination and, if necessary, operation.

All the Labrador Eskimo and the majority of the other Central Eskimo profess Christian belief, but when they pursue Christianity without the guidance of the missionary it sometimes degenerates into religious hysteria or mania which reacts unfavourably on the healthy and happy course of their lives. To demonstrate the broad-minded spirit with which the missionaries work to-day in the north, the following is a good example from Baffin Island. Recognizing the importance of the natives remaining on their trapping grounds during the short trapping season, the feast of Christmas is arranged for March, when all the natives bring their fur to the post at the end of the season. If Christmas was celebrated on December 25 it would seriously interrupt their means of livelihood; for the majority of the hunters trap at least a week's journey from the post. By the time they had returned to it, enjoyed a week's festival and gaiety, and then set out to their trapping grounds once more, three weeks would have been wasted during that part of the year upon which their prosperity so largely depends. So in Baffin Island Christmas is celebrated in Lent with the lusty singing of hymns and with sports and football matches in which the men, women, and children all partake. The mothers play football, their babies tucked away in their deerskin hoods, and should the mother stumble, out shoots the baby into the snow

or ice clothed in its birthday suit, temperature −40°. No wonder they grow up hardy.

As is only too well known to those men who shoulder the responsibilities of the north, it is no easy task to devise permanent employment or occupation for the natives throughout the year. In the first place, the trapping season lasts for only four months from November to the end of February; if fur is plentiful the hunter earns sufficient to keep himself and his family for the rest of the year, and to put by credit for a bad season. In that case, as his needs are simple, there is little incentive for him to work for the remaining eight months of the year, even if it is possible to find employment for him. On the other hand, if the trapping season fails, the native is on the charge of the Government or has to be supported by the Company, unless work can be found for him or unless there is sufficient natural food supply in that region for the hunter to support himself and his family. To my mind this problem of keeping the native employed and of keeping him active is of the very greatest moment. It brings us back to the close relationship between indolence and disease; for if the eight months' indolence of the successful trapper is one road towards disease, a still more fatal road is the hopeless and listless attitude of mind of the hunter who has failed and who is supported by the charity of his neighbours. Therefore in the internal organization of the fur trade every endeavour is made to find work for the natives during the non-trapping months of the year. Thus at Rupert's House coastal Indians and half-breeds are employed in the manufacture of canoes, which are used throughout the James Bay district, both for freight work and ordinary journeying. Likewise they are encouraged to cultivate potatoes and other crops in order to make them as self-dependent as possible in the matter of food. At Moose Factory the natives are employed at the saw-mill and at the farmery, while others are used in boat-building and schooner repair work. The schooners in James Bay are manned by Cree Indians under a white captain. Likewise in the north of Hudson Bay schooners are manned by Eskimo—and excellent sailors they make. At "ship-time" employment is found for all the natives in the handling of cargo from the ship, in sorting it and storing it and transferring it from the various depôts to the posts and outposts.

The question is sometimes asked why aircraft plays so small a part in the transport of outfits to those almost inaccessible posts in the regions which lie far inland. When it is borne in mind that in some cases over fifty portages have to be negotiated by the river routes from the coast to the inland outposts, the advantage of air transport appears obvious, but if this method were utilized to any great extent, there would be no other form of work for the Inland Indians who are employed during the spring and summer months in bringing out the fur returns to the sea-coast, and taking back with them to the interior the year's outfit of supplies for the post.

Indian women are encouraged to sew moccasins to trade at the post. The Eskimo women make sealskin boots and mitts, which are sold to the Canadian lumber camps, or traded to the Indians, who lack watertight footwear during the thaw of the early summer, their moccasins being inadequate. Instead of importing seal nets and fish nets ready-made, the twine is imported and the natives are provided with work in manufacturing the nets.

Rather than import coal to the north of Baffin Island, a seam of lignite is worked with the help of the natives, who transport the coal to the post on their *komatiks* at the end of the trapping season. In 1927 a whaling expert spent the summer among the Chipewyan Indians teaching them to catch whales, to prepare the hides, to render the oil, and to dry the meat. Furthermore, he educated them (by example) to eat whale-meat—a thing unheard of among them. Employment and natural food were found for all. On the Labrador coast the natives are engaged in the salmon and the cod fishery; thus the natural resources of the coast provide a means of livelihood for all who are prepared to work.

At posts where fishing is not practicable in the summer the natives are encouraged to hunt seals, white whales, or walrus. Special care is taken to eliminate waste. The natives are trained to dry the meat, so that every scrap is utilized. They are also trained to deal with the skins and hides according to the requirements of the London markets where they are sold, thus securing for themselves a higher tariff than it was possible to pay them before. Nearly every Eskimo family owns a whale-boat. In most cases the boats are not paid for, but by their supply the Hudson's Bay Company obtain their objective of keeping the natives mobile and of enabling them to go far afield from the posts to the less-frequented parts of the coast where hunting and trapping are best.

If left entirely to their own devices the natives tend to be dilatory with their work, and in order to accustom them to continuous rather than to spasmodic effort some of the younger fur traders are now detailed to work with them—not just to watch the work being done, but to set a standard by their own efforts. From the above examples it can be seen that the risk of pauperization is being forestalled in Hudson Bay and the north.

Quite apart from providing occupation where possible and medicines and artificial means of maintaining their independence and welfare, it is necessary to get inside the mind of the native and to kindle in his imagination certain principles of life which will help him to ride the flood of civilization in safety. In spite of the fact that many of the Eskimo have been taught by the missionaries to read and have passed on this knowledge to one another, as yet the literature of the Central Eskimo consists of the Bible and of a few religious tracts. Within the last year I set myself the task of writing for the natives a book concerning many of the basic problems which have been alluded to in this paper. It has been written in the metaphors of the Eskimo, and in graphic similes taken from the everyday life of the north. It is an attempt to help the Eskimo to guide his race safely through the problems of civilization. After the book has received the approval of the authorities on Eskimo life, it will be submitted to the Hudson's Bay Company for translation and publication, with suitable illustrations—one version in Roman characters for the Eskimo of Labrador and a second version in syllabics for the other Central Eskimo. As the numbers of the Chipewyan Indians are too small to justify the heavy cost of a book in their language, a typewriter has been constructed with their syllabic characters to enable the missionary to circulate his teaching among them.

What aboriginal race is there which within historic times has not been on

the decline? Influenza epidemics, local food shortages, contacts with civilization, the abolition of polygamy, all these influences harmful to an aboriginal (and therefore presumably dying) race have either taken their toll of life or hindered the advent of new life. I have figures only for the last three years. These figures show no decline of the population; in fact, there is a definite, though small, increase of population shown by the surplus of births over deaths. This is no lost cause, I feel, in spite of the supposition that all aboriginal races are on the decline. As a matter of fact, the increase of population on the Labrador is a little more pronounced than elsewhere. This, I think, is due to the easier conditions of life resultant from the natives living in shacks; but this admission does not alter my conviction that it would be a grave mistake to provide shacks for the Barren Land Eskimo. It would perhaps result in a higher birth-rate; but quality is surely a more important factor than quantity when the evolution (or devolution) of a race is at stake. Centuries of tent and snow-house life cannot be abandoned in the first generation of contact with civilization without dangerous consequences, which are mirrored in the physical condition and the mental outlook of the Labrador Eskimo.

A description of Hudson Bay would be incomplete without some reference to the lives of those men and women who watch over the destinies of the native in the north, following in the footsteps of Henry Kelsey, Samuel Hearne, Sir George Simpson, Dr. Rae, Chief Factor Donald A. Smith (the late Lord Strathcona), and a host of other fur traders less known to history who gave their life's work to the "Honourable Company," both before the formation of the Dominion of Canada and in these latter days. At many of the posts to-day you would find a small detachment of the Royal Canadian Mounted Police, a missionary and his wife, in addition to the establishments of the fur traders. There you will find Canadians, Newfoundlanders, Scotsmen, and Englishmen—such men and women as you would wish to find at these outposts of Empire.

No paper on Hudson Bay would be complete without reference to the arduous travels of Major Burwash, of the Department of the Interior, Ottawa, who has made journeys of research and exploration to almost every region of the Canadian Arctic and Sub-Arctic, and to a number of distinguished Canadian scientists who are working on behalf of their Government on the many scientific problems to be studied in those regions.

Finally, I would refer you to the preamble of the Charter of 1670 in which it states that the founders of the Hudson's Bay Company—

> "Have at their own great cost and charges undertaken an expedition for Hudson Bay in the North West part of America for the discovery of a new passage into the south sea, and for the finding of some trade for furs, minerals and other considerable commodities, and by such there undertaking have already made such discoveries as do encourage them to proceed further in Pursuance of their said design, by means whereof there may probably arise very great advantage to us and Our Kingdom."

Within the last few years the Company has focussed its efforts upon the discovery of a safer and shorter trade route for the transport of supplies to those finger-tips of civilization which touch the Polar Sea in the Western

Arctic, and as a result two attempts are being made to shorten the existing transport route through the Bering Strait and round the northern coast of Alaska: (1) By pushing a tractor route from Wager Inlet in the north-west corner of Hudson Bay to Cockburn Bay, south of King William Island, and thence westwards by coastal schooner to the posts in Coronation Gulf. (2) By attempting to push westwards through the North-West Passage in order to establish a practical schooner route from the Eastern to the Western Arctic.

In the spring of 1927 the Company's post manager at Wager Inlet, Mr. W. E. Brown, surveyed a tractor route across the Barren Lands between Wager Inlet and the estuary of the Hayes river in Cockburn Bay. The route, including détours, from deep water in Hudson Bay to deep water in Cockburn Bay is about 160 miles in length. It lies partly over frozen rivers and lakes and partly over the undulating boulder-strewn land. With the exception of one or two places where it may be necessary to overcome natural difficulties with engineering devices, Mr. Brown reported not unfavourably on the prospects. Two tractors have therefore been despatched to Wager Inlet for an experimental journey with freight early this spring.

Mr. Brown on this trip sledged through to the Company's post on King William Island, and in thirty-five days accomplished a round journey of 535 miles; but the only reference to himself is contained in the first sentence of his report:

> "Dear Sir,—Acting on instructions received I made a trip to King William Island via Backs River."

The following extracts from Mr. Brown's report are of considerable geographical interest:

> "On March 25th I left King William Land Post and headed East to call at a native camp about thirty-five miles from the Post on the sea ice. Here we found a total of twenty-six natives, with native Showmic apparently the head man. From native Showmic, who was the only one acquainted with the North End of Boothia Peninsula, and from the others who had lived on Boothia Isthmus and sealed in Lord Mayor Bay, I was able to gather the following information: The whole of the Gulf of Boothia is covered with heavy pack-ice all the summer, especially to the south of Victoria Harbour. Lord Mayor Bay is also usually full of heavy pack-ice. With a favourable wind there is usually a lead of open water along the East Coast of Boothia Isthmus as far south as Victoria Harbour. With a change of wind the pack-ice piles up against the coast again and closes the lead. Victoria Harbour, except during adverse winds, is usually clear of ice during the summer. According to the natives there are pieces of large rope and bits of iron lying about here. They also report that a ship was wrecked a long time ago near this point, on what is possibly the Astronomical Society Islands. Showmic also states that whenever he has summered along the West Coast of Boothia Peninsula, he has always seen open water, with sometimes some pack-ice driven down from (apparently) McClintock Channel and blocking Sir James Ross Strait; this ice, though, apparently does not stay along the Strait. He also said that a number of years ago while living near Bellot Strait heavy ice came down from (apparently) Prince Regent Inlet and blocked the entrance to the Straits. Up to the time he left, which was four years later, the ice was still

there, but he had heard from natives who had been there at a later date that the ice was now gone."

These, then, are the things which are happening in Hudson Bay to-day, as the result of the seal of a King attached to a few square feet of parchment on 2 May 1670.

DISCUSSION

Before the paper the CHAIRMAN (Admiral Sir WILLIAM GOODENOUGH) said: There are many romantic spots in the American continent—Quebec, New Orleans, the Rocky Mountains—but I do not suppose there is any area that combines romance and geographical importance in the same degree as the Hudson Bay area. It is not my intention to give you any history of that area. You will find it in a very charming book issued by the Hudson's Bay Company, entitled 'Hudson's Bay from 1670–1920.' To-night we are going to be brought even farther into our own time, and I will invite Mr. Binney to give us his lecture on "Hudson Bay in 1928."

Mr. Binney then read the paper printed above, and a discussion followed.

THE GOVERNOR OF THE HUDSON'S BAY COMPANY: Mr. Binney has given a very interesting description of Hudson Bay in 1928, its people, and the conditions in which they live. I must confess to being envious of his good fortune, of the voyages which he has already accomplished, and the great field for discovery which he has set out to master whilst still in the heyday of life. Nothing would please me better than to see those regions for myself, and I look forward to the time when more pressing duties will relax so far as to give me the opportunity.

As Mr. Binney has mentioned the Hudson's Bay Company, and indeed with such a subject it is impossible to ignore us, allow me to suggest to you what such places as you have seen on the screen signify both in history and geography. Rupert's House, York Factory, Fort Churchill: they take us far back in time to the days of Prince Rupert, the first Governor, the Duke of York, the second, and the Duke of Marlborough, the third Governor of the Company of Adventurers of England trading into Hudson's Bay, and to a Charter granted by King Charles II, not only for the purpose of trade, but with a great geographical object also, no less than the discovery of a passage to the South Seas.

An audience such as this is not likely to forget what that meant to our ancestors: behind the obvious rivalry of England and France for the possession of the Fur Trade lay the rivalry of two maritime powers, for the key, as it was then thought, of the trade of the World through a passage to the south by way of the north, which should open out the Pacific and China to our adventuring sailors. Such was one of the great objects of nearly half a century of war, marked in those northern regions by the taking and re-taking of trading posts; and when the Treaty of Utrecht brought peace, the Company took advantage of the respite to organize a voyage for that discovery. Captain James Knight set sail from York Factory in 1719; but the two vessels were wrecked and all lives lost, and later expeditions only confirmed the view that, so far as the Hudson's Bay was concerned, no such passage existed.

Nevertheless, the Company maintained its persistent and continuous tradition. One hundred years later, in 1824, Sir George Simpson set out from York Factory, establishing by river and lake, portage and traverse, a road to the Pacific coast, which he maintained was the shortest route between London and China; and one hundred years later still, that is to say, with the opening of the Hudson Bay railway to the port of Churchill in 1930, his dream will be an accomplished fact. But though railways have long since conquered the continent

which barred the way from Europe to the East, the Company has persisted in the geographical aim which was the origin of its existence, and for many years past has been steadily extending its posts and communications from the Western Arctic eastwards and from the Eastern Arctic westwards, until almost the whole length of the North-West Passage is dotted by our trading stations. Only a few months ago, the Company's steamer *Baychimo*, venturing farther east than ever before, landed at Perry River supplies and building materials which were transshipped to Peterson Bay on King William's Island. From the opposite direction the M.S. *Fort James* sailed along the shores of Baffin Land, through Lancaster Sound and Peel Channel, until she is now wintering on the western coast of the Boothia Peninsula, a few miles south-east of the Magnetic Pole. It would have been an easy matter for the *Fort James* to have gone west until she passed out through the Bering Sea; but, as it may interest you to know, she is being kept in winter quarters for the purpose of survey and observation. For we have in mind the establishment of a warehouse for emergency supplies in Cockburn Bay on a land route from Wager Inlet, already explored by several of our men, which will complete the line of communication along the Western Arctic into Hudson's Bay.

So you see that after 260 years, Hudson Bay in the east has actually been linked with the west by the far-flung line of our posts on the northern shores of the American continent, and we have not merely explored but occupied the North-West Passage by the process of trade. Thus we have followed in our practical way that national policy which was first formulated in the Charter of King Charles II and in pursuance of which Parliament has from time to time offered rewards. All that arduous work, in circumstances of hardship and sometimes of danger, deserves a tribute no less high than the outstanding achievements of the explorers who have passed across the screen. It is by edging along from point to point, generation after generation, that the great work of occupying the Arctic and the North-West Passage has been done.

Sir William Butler, writing fifty years ago, paid such a tribute to the men of the Hudson's Bay Company, and I cannot do better than quote some of his words: "To the east nothing but a vast expanse of ice-covered sea, with a blue cold skyline; to the north, a shore of rocks and hills, wind-swept, and on the rising shore the clustered buildings of a large fort with a red flag flying above them in the cold north blast. The flag—well, we all know it, but it is only when the wanderer's eye meets it in some lone spot like this that he turns to it as the emblem of a home which distance has shrined deeper in his heart."

They have kept the flag flying—holding the territory until it became part of the Great Dominion, that "captain jewel in the carcanet," of what we proudly call the British Empire.

The CHAIRMAN: We thank Mr. Binney and also the Governor of the Hudson's Bay Company, and I ask you, Mr. Binney, on behalf not only of this audience but of the Royal Geographical Society, to accept our very hearty thanks for a most agreeable and interesting evening. I can assure you that you have given us much food for thought, not only by the description of various places to which you have referred but in certain points which you have brought before us which are full of importance to this country. I was particularly glad to hear of the railway up to Hudson Bay and sea transport from thence, and the possibilities of overcoming difficulties in the transport of wheat or corn to this country. I may be prejudiced, having been at sea for forty-seven years, but I ask you to take the opportunity of comparing the advantage of taking things by sea as against taking them by land.

There is another matter I would mention. Many people come to lecture to

us from all parts of the world, but none come without having an extraordinarily good word to say for the natives they meet. You have heard Mr. Binney speak well of the Eskimo. A fortnight ago you heard Mr. Baker speak well of the natives of the New Hebrides, and a little while before that Mr. Lattimore spoke in the same sense of the Mongols. It is the greatest possible encouragement to those who follow the travels of people to find that they discover what is good rather than what is bad among the natives with whom they come in contact. Our business concludes with my offering to you, Mr. Binney, the vote passed by the audience of very sincere thanks for your exceedingly interesting lecture.

Mr. R. I. MONEY writes: I was interested in listening to Mr. Binney's lecture, having been a member of the first survey party sent over the ground from Winnipeg to Hudson Bay, in the autumn and winter of 1885, to see if a railway was feasible. We found no engineering difficulties, and it became only a question of for how long Hudson Strait was navigable. Dr. Bell, of the Canadian Geological Survey, who had made five voyages through the Strait, reported that it was navigable from mid-June to mid-November, or five months. The Canadian Government Expeditions of 1884, '85, '86, under Lieut. Gordon, reported four months. Capt. (Admiral) Markham, who accompanied the expedition of 1886, reported "at least four and probably often for five or more." The vessels employed on these expedition were in 1884 the S.S. *Neptune*, a Newfoundland sealing vessel of 684 tons and the first steamer that ever entered Hudson Bay, and in 1885, 1886, H.M.S. *Alert*, of 700 tons and 50 horse-power. In these days of cargo steamers with a carrying capacity of 10,000 to 20,000 tons it seems almost ridiculous to hear of a steamer of 700 tons and 50 horse-power being sent to test the navigability of the Strait, more particularly as there were neither buoys nor lights. It might be supposed that with the Strait properly lighted and buoyed, and steamers of the present-day capacity and power, specially built to withstand floating ice, navigation of the Strait might be feasible for a longer period than five months, and I should like to ask Mr. Binney whether he can throw any light on this point.

Mr. BINNEY replies: Mr. Money raises the most difficult and speculative problem of all, and I purposely avoided direct reference to it in my paper because no data in possession of the Hudson's Bay Company throws a light on the number of months in the year in which Hudson Strait is commercially open to navigation.

In the early days of sailing ships and in the pre-war days of small auxiliary steamships it was necessary to avoid the doubtful months of July and November because the vessels did not have sufficient power to make headway in heavy ice, although as a matter of fact, being wooden vessels they were less liable to damage from ice than the steel or iron ships of to-day.

Mr. Money, being an engineer, will appreciate that bilge keels are likely to be damaged and rivets to be strained in forcing a vessel through ice, and therefore, unless ice-resisting vessels are built for this northern trade route, shipowners will not wish their vessels to be in those waters during the doubtful months when ice may be encountered.

Finally, I would refer Mr. Money to that point which I tried to develop in my lecture, that local ice conditions are rarely similar two years in succession, and that we are now enjoying a period of favourable ice years, judging by the records of to-day compared with the records of thirty years ago; but whether this amelioration is a mere phase in a cycle of ice conditions or a fluctuation, or whether there is no rhyme or reason to it whatever, it is impossible to say. These things are beyond scientific knowledge as yet.

THE KALAMBO RIVER AND FALLS: *A paper read with the two following papers at the Evening Meeting of the Society, 4 March 1929, by*

MRS. ENID GORDON-GALLIEN

I DO not propose to say very much about the Kalambo falls, as Mr. Cornwall and Mr. Rose will describe them fully, both from a survey and from a geological point of view. My part is simply to give you a short description of our journey from Dar es Salaam to Kalambo and back. Our object in going to the Kalambo river was to fix, definitely, the position of the falls. Although reports and photographs of them had been received from time to time by the Royal Geographical Society, they had never been mapped. It was with the intention of doing this that we went out there. Mr. Cornwall undertook the survey, and Mr. Rose the geological part of the work. Here I may say, it was partly due to our President, Sir Charles Close, that this particular piece of work was chosen. It was he who told me of the survey work to be done at the falls; and I should like to thank him very much indeed for the interest he showed and for the helpful advice he gave us before we left London.

I should also like to express my appreciation of the work done by Mr. Cornwall and Mr. Rose on this trip. They did all they could to make it a success; and whilst travelling, no discomfort ever seemed to worry them, and no annoyance ever seemed able to make them lose their tempers. I particularly wish to thank Mr. Reeves for his kindness. From the time I first made his acquaintance in the Instruction Room he has done everything he possibly could to help and encourage me.

We arrived at Dar es Salaam on Friday afternoon, June 15. Finding our train left for Tanganyika the following Monday at nine p.m., we had only the week-end in which to clear our luggage through the customs, collect stores, see various officials, get shooting permits, and do the hundred and one odds and ends that crop up at the eleventh hour.

Through the kind offices of Mr. Reeves, Captain Wilson and Colonel Dale of the East African Dependencies in London, we had received letters to the directors of several Government Departments in Tanganyika. During that week-end we met the head of the astronomical section of the Survey Department, and he very kindly offered any help we needed. I discovered the Department knew roughly where the Kalambo falls were, and were not greatly concerned with their exact position. But there was a piece of work they really wanted done, the accurate determination of the longitude of Kigoma. We assured him that we should be delighted to do the work if time allowed.

At nine o'clock punctually the following Monday evening we left by train for Kigoma. The line running from Dar es Salaam was started by the Germans in 1905 and finished in 1914. It was intended as a main trunk line and is therefore well constructed. The route taken by the railway is more or less the old Arab trade route, along which the slaves were brought from Central Africa to the coast. The first part of the journey (we saw this by daylight on our return journey) is through plantations of coconuts, the line rising slowly to the plateau and reaching 200 metres at its highest point.

Then it goes down again through more coconuts, old rubber plantations and sisal to Ruvu, which is nearly at sea-level. Next comes a dull country of thorn bushes and baobab trees, and then the line rises to Morogoro at the foot of the Uluguru Mountains. Afterwards the train climbs a steep pass and crosses Mkata plain; here are great flats of grass and bush backed by mountain scarps. West of Kilosa (where one of the main roads starts to the south-west via Iringa) the line runs on through cotton, sisal, mangoes, mahogo and Indian corn. Bananas and oranges grow there too; and stiff candelabra euphorbia, its pink-tipped leaves reminiscent of flaming altar candlesticks. We arrived at Dodoma 4.50 p.m. on Tuesday, and most of our passengers disembarked.

The next important station is Tabora. East and west of it stretch hundreds of miles of savannah forest. This is as yet uncultivated; but it has, I believe, all the possibilities of fine wheat country. Before reaching Tabora the line cuts the great East African Rift Valley, which runs down as far as 6° south latitude. Kilometre 634 is the highest point of the line (4350 feet), and at kilometre 785 it crosses the Continental Divide. West of this the water flows into lake Tanganyika and so, through the Congo, into the Atlantic.

Tabora is a famous old town, the capital of the Unyamwezi country. Stanley and Livingstone lived near here in 1872; and battlegrounds lie close over which Arabs and Unyamwezi kings, Germans and Belgians, fought. Soon after midnight on Wednesday we reached Kigoma.

On Thursday morning we breakfasted at the Kigoma Hotel, and inspected the township. We then felt it time to tackle our problems: how we should unload, and what we should do with our luggage when we had unloaded; whether we should catch the boat going south that same afternoon, or stay, find the longitude of Kigoma, and take the next boat a fortnight later. To solve the last problem, Mr. Cornwall interviewed the Acting Provincial Commissioner, who happened to be at Kigoma. On his advice we decided to stay. By so doing we could not only do the necessary astronomical work, but would also give him time to put officials in motion and have porters waiting for us on our arrival at Kasanga. As to our luggage, the *boma* officials kindly lent us a squad of convicts commanded by an *askari*, and they mastered the problem in no time. The Provincial Commissioner chose a camp site for us under some big shady mango trees, on the hillside overlooking the bay; there the convicts assembled our luggage and pitched our tents.

For two weeks, night after night, Mr. Cornwall set up his theodolite on the hillside above our camp and observed often until one or two a.m. The nights were wonderful: clear skies—with perhaps a few wispy clouds—and brilliant stars. Our wireless worked well. We picked up Bordeaux and Rugby with scarcely any trouble, and were able each day to check the rate of the chronometer.

Kigoma as a residential station has charm. The bungalows are built on the hill slopes with a view across the water to the remote blue of the Congo ranges. It has typical Greek stores and Indian dukas on each side of the wide red road that runs steeply up from the station through the township and on to Ujiji, about 5 miles along the coast. Ujiji was an old slave-trading centre. It must have had a huge population in those slave-trading days; even now, when its reason for being exists no longer, ten thousand people still live there. On a

lower level, between the lake and the town, grows an historic tree—the tree under which Livingstone and Stanley met. It seems to be gradually dying. Already its branches have decayed a good deal, and spiders and other insects weave their nests amongst the leaves. However, the Provincial Commissioner told us the tree would not be standing there much longer. The Tanganyikan Government has voted £50 for a memorial to be erected on that spot, and this Society has already sent out a bronze plate with the following inscription:

"Under the mango tree, which then stood here,
H. M. Stanley met David Livingstone,
10 November, 1871."

The District Officer is grafting parts of the old tree on to some young mango trees, and when these are ready they are to be planted at the four corners of the memorial. We actually saw this bronze plate, and also the young mango trees, which appeared to be in a very flourishing condition.

One morning was spent at the native court of Ujiji. This was held in a small thatched *banda*. At one end was a raised dais; on the dais, the bench; and on the bench, the Judge and Elders dressed in silk *kanzus* of every colour of the rainbow, embroidered in gold and silver. The Court beckoned us up to the bench, and we sat there feeling rather like wrens amongst birds of Paradise.

The proceedings were surprisingly dignified. The Court took itself seriously and expected onlookers to do the same; if they did not, they were charged with contempt of court. This system of having native courts in Tanganyika is part of an experiment which is being tried by the British Government. The pre-war German policy was to break the power of the native chiefs; but this policy is now completely reversed, and the people are led to govern themselves as far as possible. They have two native courts, a lower and a higher, and if neither of these can settle a case, it may go, on final appeal, to the Provincial Commissioner. It was interesting to hear from the Provincial Commissioner at Kigoma, that during all his experience he had never known a case go beyond the higher native court.

The Government collects a hut tax in Tanganyika, but has no forced labour. When a man has paid his tax he is free to work or not as he chooses. If he does work, he is well paid for it. We were told that as the native becomes more civilized he seems to become more energetic. A case in point was a tribe called the Wa Ha, who frequented Kigoma. They were quite a *shenzi* people, wearing nothing but a skin or a piece of cloth fastened on the shoulder. When the Provincial Commissioner had first known them they refused to do work of any kind. Now, he said, they came into the township actually hunting for work, and even went as far as the coast in search of it.

On July 5 we pulled down our tents, packed up our gear, and boarded the lake steamer *Liemba*. She was a comfortable boat of about 600 tons. It was difficult to believe that she had been at the botton of the lake for seven years. She was sunk during the war. When fighting was at an end, the task of raising her was handed over to a couple of Englishmen, who had her up in twenty months, reconditioned her, and now to all appearance she is as good as new.

From 4 p.m. Thursday until 8 a.m. Monday morning we spent on the *Liemba*. Each day the ship called at places along the coast; sometimes at a

mission station, sometimes at a native village. Kasanga, which we reached on Monday, was built on the low-lying shore, the *boma* being on a high bluff beside it. The latter having been put at our disposal, we sent our luggage there direct, landing ourselves at the town to see what little there was to be seen. Kasanga had been at one time the German naval base, but the only visible sign distinguishing it from other native villages was its big walled *boma*, with a sentry box still standing at the entrance gate.

Those who have been on *safari* know the trials of the first morning. Porters are late; loads must be rearranged; delay and muddle are the order of the day. Our first morning was no exception to this rule; but we got off at last, mounted the hill behind the *boma*, and started our walk to Kalambo. The track ran through forest country, with light undergrowth; shrubs and young leaves were tipped with bronze and yellow, pleasant to the eye.

After following this main track for several miles, we left it to pick a dry, stony, slippery way across to the Kalambo gorge. Our first view of the cliffs near the falls was most impressive. From the gorge they rose, sheer and stark, hundreds of feet high. Approaching them, the roar of falling water could be heard although the falls themselves were not to be seen.

At the camp site we found kitchen, *banda* and porters' huts already built, which left us only tent sites to choose and clear, and tents to pitch. Later we climbed down the cliff and had our first view of the falls. Above them the Kalambo river lay very calm and peaceful, reflecting green of overhanging trees; but as the water plunged over the lip and fell more than 700 feet to the gorge below, it looked like a sheet of liquid snow.

The surrounding cliffs were sandstone-russet, and red, apricot, violet and gold, a veritable Joseph's coat of many colours. Blue and white marabout storks lived on the cliff ledges or floated over the gorge, shining as steel in the sunlight. Down at the foot of the falls the atmosphere is drenched with spray falling as a continuous rain. A mass of vegetation grows underfoot and on the cliff face. Some short distance downstream are two further falls, one about 50 feet high, the other about 27. Below, the gorge closes into a narrow pass with extremely high straight walls.

There was extraordinarily little native population round Kalambo; perhaps five small villages within a radius of 10 miles, and hardly any cultivation. Usually each village possessed a tobacco plot, and just outside the village was a bit of cultivated ground. Beyond these, however, the natives seemed to do practically no work. They had neither cattle nor goats, and few fowls. This scarcity made catering rather difficult. Eggs, fish, meat and bananas came from Kasanga, a two days' journey for the porters. Vegetables were procurable only at Mwazia, a French mission station, four days' journey for the porters.

During the time spent at Kalambo two expeditions were made from the main camp: one to Mwina on the lake, and the other to Sansia (or Sanvia), about 10 miles up-stream. Time passed in much the same routine. Reconnaissance and building beacons filled the first fortnight, and after this preliminary work came triangulation and plane-tabling.

Work was finally finished by the third week in August, and we left camp on August 22 and trekked across to Abercorn, some 20 miles south of the

Kalambo river (which was here the boundary between Northern Rhodesia and Tanganyika Territory).

We had arranged to motor back to the railway instead of returning by the lake route and were to pick up our motor-lorry at Abercorn. Abercorn was reached on the 24th, and next morning we piled ourselves and our belongings on to a Chevrolet and started for the north. Here are some notes on the road from Abercorn to Kilosa, taken from Mr. Cornwall's diary:

"South on the Kasama road nearly to Sunzu. Good road; fairly level, through thin bush country. Just north of Sunzu our road diverged S.E. from the Kasama road and ran down a valley. Rocky and dense vegetation.

"The road bent round Sunzu on its south side and ran almost due east for 60 miles to the boundary. Road bad—over a series of streams; a 'switch-back' of forest-clad ridges and wide green watercourses.

"Twenty miles or so from Ikawa a new road has been cut N.E. across the boundary; still crossing many streams but rising gradually to the high bush country in which Mbozi is situated.

"Once up on this plateau the road improved, though there were still stream-crossings with steep pitches on the far side to be contended with. New cuts of road took us N. of Igali on high ground with views across the vale to Mbeya, and then down into the vale by easy gradient; road badly drained and cut by flood-water channels.

"The road did not go into Utengule nor into New Utengule. Here it ran over open rolling grass country; good road. Then on to Buhora Flats. Frequent watercourses to cross; road patchy and obviously difficult in the rains; flat bush country.

"At Malangali the road rises out of the plain to higher ground—thickly wooded at first—then on to the plateau more open parklike country; good road. And so up to Iringa. From Iringa via a mountain road down to the valley of the Ruaha. Road good. Across the Ruaha the road winds up a steep ridge; good gradients, then over and down a somewhat mountainous road to the plains, and so to Kilosa."

On the Buhora flats game is very plentiful. Even from the car we saw herds of *mpala* and duiker, or *dik dik;* the *mpala*, slim and graceful, standing for a moment to watch us before disappearing with great bounding leaps. The farther north we drove the more traffic we met. Laden lorries driven by Indians tore past; a carful of German settlers and their *haus fraus* once overtook us; just south of Iringa, farms, cultivation, even brick houses, appeared; and our driver was amused and surprised at a post-and-rail fence—the first he had ever seen in Central Africa.

Iringa was the one large township on this northern route. It possessed two hotels and many stores. Here we heard that the road to Kilosa was now open, and decided to try it instead of the one to Dodoma, farther west. After descending the steep mountain roads north of Iringa we travelled through fertile valleys and then across the plains. The days had now lost their high-altitude freshness, but the nights were still cool. Our train from Kilosa left at 6 a.m. on September 2, and our last camp was made just outside the township.

At 3 a.m. we rose and dressed by moonlight. By moonlight the lorry was repacked. At 4 a.m. we reached the station and dragged out a protesting clerk. Soon after six the train arrived, and we boarded it en route for Dar es Salaam.

THE SURVEY OF THE KALAMBO GORGE: *A paper read with the preceding at the Evening Meeting of the Society, 4 March 1929, by*

J. W. CORNWALL, R.A.

WE set out with the intention of mapping an area of about 100 square miles to show the course of the Kalambo river where it drops over the edge of the Great Tanganyika Plateau into the depression of the lake, and with the particular object of fixing the position of the falls which were known to exist there.

Members of the British Commission, which, with the Germans, demarcated the boundary (here the river) in 1898, noted a deep gorge near the lake and looked for the falls which they knew must exist but did not see them; nor, apparently, did they meet any one who had seen them. Since then they have, of course, become well known to local settlers in Northern Rhodesia; but in quite recent years there have appeared in print conflicting accounts as to the distance of the falls from the lake and as to their depth. Their position is only shown approximately on the most recently published map.

We had a good deal of data and information to start with. There was the work of the Boundary Commission of 1898, which resulted in two maps of the area, the English and the German. Though, of course, these coincided in framework, in detail, *i.e.* the course of the river, hill features, etc., they differed. The values of this framework (*i.e.* triangulation) had more recently been brought into harmony with the major triangulation in Northern Rhodesia. We took a trace of the portion of the German map which affected us and a list of revised values of the trigonometrical points it contained. We hoped, perhaps faintly, to be able to find the cairns left over the "trig." points by the Germans and the British Commission. But it was thirty years since they were there, so we had to be prepared to do without them.

From recollections of members of the British Commission and from travellers' accounts which were quoted in the *Journal* for March 1926, we were able to form an idea of the sort of country it was and what, more or less, we had to compete with. But I must confess that my picture was wrong. I imagined that, apart from the actual lake and river-banks, it would be a fairly open, rolling, veldt country, with occasional patches of bush. The information I gathered from people on the way out seemed rather to confirm than to belie this.

We had to be prepared to initiate our own triangulation, so we took a portable wireless receiving set for getting wireless time signals. We had besides a micrometer theodolite with 5-inch horizontal and 4-inch vertical circles, plane-table, telescopic alidade, Indian clinometer, aneroids and other essential surveying equipment. We also had some plane-table sheets ready graticuled, at 1/50,000, and the few trig. points we hoped to find ready plotted. In Kigoma we bought many yards of white and yellow *Americani* (cotton sheeting) for beacons, flags, etc. Julius Jackson, one of the boys we engaged at Kigoma, thought that it was to make *kanzus* for him.

We arrived at Kasanga on the morning of Monday, July 9—two months after sailing from London. Fifty porters were awaiting us, and it was difficult work collecting them and starting them off early the following morning, after a night spent in the old German *boma*.

The path to the Kalambo falls and thence on to Abercorn is fairly direct, and runs for the most part along a ridge between the Kawa valley and the lake. The whole district is thickly wooded; for the first 5 miles as we rose from the lake-shore the scenery—views up the valley on one side and over the lake on the other—was very beautiful. After reaching the top of the ridge the path ran monotonously, mile after mile, straight and flat through unbroken forest. Once only we got a glimpse of the lake through the trees, and then it appeared on our left when I, at any rate, imagined that it was on our right. I diverged once to look for traces of a cairn when we thought we should be near one of the trig. points, but found nothing, and could get no view even by climbing a tree.

It was a good 10 miles to the falls. The path, which had for some way been sloping gently down, turned suddenly up a steep hill, and at the top we found ourselves on an old camping-site. A tall native welcomed us rather as though we were entering his property. He, we found, was Kanuka, of the local hamlet, the self-constituted showman of the falls. We discovered later that this hill was a fortified German frontier post during the War, and we saw remains of trenches excellently sited to cover the crossing at the lip of the falls.

So far there was no sign of falls or river to be seen, but a roar, not loud but deep and tremendous, told us what lay beyond the hill. We pitched our tents a little apart from the old camp, and then, in the evening light, went down to see the wonder that lay beyond.

It was indescribable—the grandeur of it was unbelievable. Here suddenly the wooded hillsides stopped abruptly and cliffs sank dizzily into a chasm. It was as if the hills had been cleft apart. We looked out into a sea of space, and far below a little rivulet trickled, between dark green banks, out of sight, engulfed in a winding gorge. Precipitous headlands on either side stood out dark against the evening sky, and beyond them, backing the vista, shone a strange light like burnished brass. It was the lake, set ablaze by the sinking sun.

The impression I had received during the day's march through the monotonous forest had been one of disappointment. It had seemed a country without life, worn out, uninteresting. But now, as we sat in this splendid place, we acknowledged that this surpassed all our dreams, and we climbed back to our camp elated and refreshed.

We had about five weeks before us in which to work. Our main objective was the fixation of the falls, and then the mapping of the river course from the lake to the plateau, as far as time would allow. In view of the closeness and the apparent dullness and sameness of the district in general and of the time limit, we decided that any extensive triangulation, other than that necessary to achieve the main object, was out of the question. Much depended on whether we could find any traces of the old trig. points. The most obvious one would be that on the lake-shore. If we failed to find any more, here would seem the most obvious place for measuring a base and originating a triangulation. The only height we knew was that of the lake—773 metres.

We decided to start with a central camp on the hill by the falls and to operate from there. We planned first to reconnoitre with a small plane-table to locate some of the trig. points if possible, starting with Mwina on the lake, and to beacon points for carrying a triangulation up from the lake. Then we would observe the triangulation, compute, and plot the points on a plane-table; then plane-table the area from the lake up to the fall, and finally extend by plane-table triangulation up the river as far as possible. I expected we should need a month, probably, for the first three parts of the work.

On July 11 we set out for the river mouth, with six porters carrying axes, *pangas*, spades, and food. Our aim was to find the Mwina trig. point and to obtain a line from there on to the position of the two nearest ones—Kikuma on the north and Polungu on the south of the river. Kanuka, the man who had greeted us on arrival, constituted himself our guide and led us down to the lake-shore by a roundabout path, for we had to cross the head of a steep valley which joined the gorge. The final descent to the lake-level was very steep. Here the gorge had widened and the river twisted through flats where grew tall grass and reeds and an occasional tree. We came upon a hamlet, a rare occurrence in this neighbourhood. It was a collection of three or four huts called Mwinambao.

We reached the lake-shore after crossing half a mile of sand and found a fishing village, Kipwa, at the water's edge, protected by the spit of sand, called Mwina, on which we hoped to find a cairn. A man of the village understood at once what we were seeking, and led us to the spot where the *bwanas* had set up a telescope (*darabini*). From the German description we expected to find it on a sand-dune towards the end of the spit; actually we found a heap of stones sunk in a swampy patch of reeds 200 yards from the end of the spit. There are violent storms on the lake, and we were told that this bar of sand was frequently wave-swept. Here was a good place for measuring a base if need be.

There was a good view up the gorge for about 3 miles to where the river bent sharply to the south. By taking bearings we could see approximately where the two nearest trig. points ought to be, but there was no break in the forest or obvious feature to indicate their position. The villagers produced an old iron telegraph pole and socket, and we erected this as a beacon with a coloured ball at the top. (The Kigoma–Abercorn Telegraph line ran by here.)

The next two days were spent in searching for traces of Kikuma and Polungu trig. points. The first day we failed to find any trace on Kikuma hill, though the approximate point where it should be was obvious. I believe there are two rules to which every surveyor should adhere: Leave permanent marks over your trig. points and site them on the top of hills. Both had apparently been ignored by our predecessors (the Germans, on this side of the gorge). Rather than let the day be fruitless, we cleared a space on a spur looking over the gorge and erected a beacon (white bunting on a tree pole). The forest seemed dead and deserted; we neither saw nor heard any sign of human, bird or animal life till we got back to camp in the evening, where, as always at this time of day, clouds of swifts were circling over the falls.

The next day proved lucky, for we found traces of the trig. point on

Polungu hill. They were quite definite this time, the point being on the top of the hill. (This was in Northern Rhodesia.)

We had to ford the river on starting out, about 400 yards above the falls. In places it was waist-high and there was a strong current. Our porters, who spread over the hilltop with instructions to look for heaps of stones, were delighted to find five heaps, one at each point of the compass and one in the middle. This was obviously the place. All around were axed stumps—signs of tree felling, though of course others were now growing in their place. Actually the tallest tree we had to fell, 40–50 feet high, was growing from one of these stumps. We removed the centre heap of stones and dug, hoping to find a station mark, but found nothing. We cleared trees where views were needed and erected a 40-foot mast, with a bunting flag at the top and a white apron at the bottom. It was a relief to have found this trig. point, for now we had a base for our triangulation.

The next few days were spent in selecting and beaconing suitable points. We searched without avail for the trig. point on Kiungu hill. We gave distinguishing names to each point, keeping to the native names, of course, whenever they existed. From each point we drew a rough panorama of the view, with compass bearings on it. These panoramas were a great help when it came to plane-tabling and contouring.

Our porters were a thoroughly idle lot and needed hustling continually—save Joseph and James. Joseph was always doing all the work himself instead of making the others do it. He would borrow Kanuka's little native hatchet and lop off branches, clinging to a tree-top with his toes and one skinny hand. The trees were mainly soft and cut easily; the most common sort had red sap, like blood.

A reverse azimuth and distance were computed between Mwina and Polungu, and then the former was taken as the origin of a rectangular grid to simplify the computing and plotting of the triangulation.

The wind was annoying while we were observing and plane-tabling. It would rise at about 9 p.m. each night and blow a moderate gale till the following mid-day, when it would drop suddenly to a dead calm. Then the bunting on beacons and flags would hang limp instead of flapping, and was difficult to pick up; also there came a shimmer, which added to the difficulty, especially across the gorge, where there was a great deal of bare rock which caught the light. With the calm, too, came the heat and the lake flies; but, apart from these minor discomforts, the conditions were perfect.

We arranged that we observed last at Mwina, and started plane-tabling from there. We spent two nights there. The villagers built us some grass shelters which kept off the wind. We worked back on the Rhodesian side, and so had to cross the river about a mile from the mouth. The force of the current was astonishing. The water was nearly waist-deep in parts, and the bed of the river, boulder and rock strewn, was about 30 feet across. We got heights plane-tabling chiefly with the Indian clinometer. The contouring was not difficult, as from one side of the gorge the form-lines of the opposite side could be drawn in. Altogether we put up about twenty-five flags and marks, mostly in trees. By August 4 we had plane-tabled up to, and just above, the falls and had inked in the work. So far we had taken three and a half weeks.

Closer view from Rhodesian side

Kalambo Falls from Rhodesian side of Gorge

Lip of the Falls

Pool at base of Falls

We heard of more falls at a place called Sansia, or Sanvia (which means "rapids"). "Nine or ten hours up the river," Kanuka said, so in the remaining time we decided to carry a plane-table triangulation up to these falls.

The land generally dips towards the lake in a series of ridges, layered one on another and thickly tree clad, with occasional patches of yellow grass. The river flows, for the most part invisible, between thickly wooded banks. We reconnoitred along the second ridge from the lake. We named this "Burnt Ridge," for on it were the only patches in the neighbourhood that had as yet been burnt, and consequently it was the only place where game was regularly seen. We had previously fixed a giant tree—"Crump Tree"—on this ridge, and we fixed two more points on it and flagged them. From near the second point the Sansia falls and rapids could be seen, a white smudge 5 miles away, and the only noticeable feature in the landscape. The rest was just an undulating sea of trees. From our flag on Burnt Ridge we then fixed two points farther along the Kiungu ridge, here called Kanyikauiwilo, from whence we got a fair view across to the Sansia falls. In the intervening country all that could be seen of the river was at an occasional bend where the trees grew tall. The haze from mid-day onwards was now getting bad.

We then trekked to Sansia to work from that end. We started at eight and prepared to stop three nights there. At a village called Namakali we left the *Bacaroni* path and pursued a trackless course, guided by Kanuka, reaching our goal at 2 p.m. Almost the whole way we were shut in by trees and could see nothing, but the ridge the river tumbles off at Sansia stood higher and there was a good view back over the intervening country to Burnt Ridge and Kiungu ridge.

Beside the rocky channel of the river there was an ideal camping site. We spent three nights here, plane-tabling, looking for game, and reconnoitring upstream with a view to possibly running a plane-table traverse up to the junction of the Samfu, closing on a "problematical" trig. point there. Just a mile above the falls, however, the jungle became so dense that further progress was useless. Great trees grew thick along a boggy margin at the water's edge, and on the banks thick grass and bracken grew to 5 or 6 feet. We explored outwards at right angles to the river on both banks, but the slopes were here flatter and more sweeping; the trees grew thick as ever and plane-tabling was impossible. The only game I gained contact with was a flock of guinea-fowl.

The day we left Sansia they started to burn the forest on the Rhodesian side of the river. We watched the fire from a hill on the opposite bank; an awe-inspiring spectacle. The result was a smoky haze for the rest of our stay at Kalambo. It was lucky they did not start a few weeks sooner, or visibility would have been nil.

The following are estimations of the depth of the falls by various people, culled from references in the *Geographical Journal* and from local English people, and each put forward as the accepted depth of the clear drop: 1200 feet; 700 feet; 1700 feet; 900 feet; 880 feet (this by plumbing, guaranteed to nearest 15 feet); 675 feet (this by aneroid, guaranteed to nearest 15 feet); 720 feet; 750 feet. From the above it is obvious that to obtain a correct figure for the depth is not a simple matter. The whole fall can only be seen from certain points along Chasm Cliff edge; moreover, the river does not shoot

Pool at base of Falls

Lip of the Falls

out at right angles to the cliff face, but sideways, owing to the formation of the lip, and the pool into which it falls is partly obscured by a corner of rock and is shrouded in mist.

I calculated the depth by observation from two points—Chasm Cliff and Photo Point, using the latter as a check on the former. From this the depth was 214 metres, *i.e.* 705 feet. I got a further check by observation on the lip of the falls to a point, Blarst Rock.

An attempt to corroborate by careful aneroid readings failed, owing probably, I have since learnt, to not allowing the aneroid sufficient time to settle. A point perhaps worth noting with regard to this is that of the great difference in humidity between the top of the fall, where the air is hot and dry, and the bottom, where the air is drenched in spray and mist.

THE GEOLOGY OF THE KALAMBO GORGE: *A paper read with the two preceding at the Evening Meeting of the Society, 4 March 1929, by*

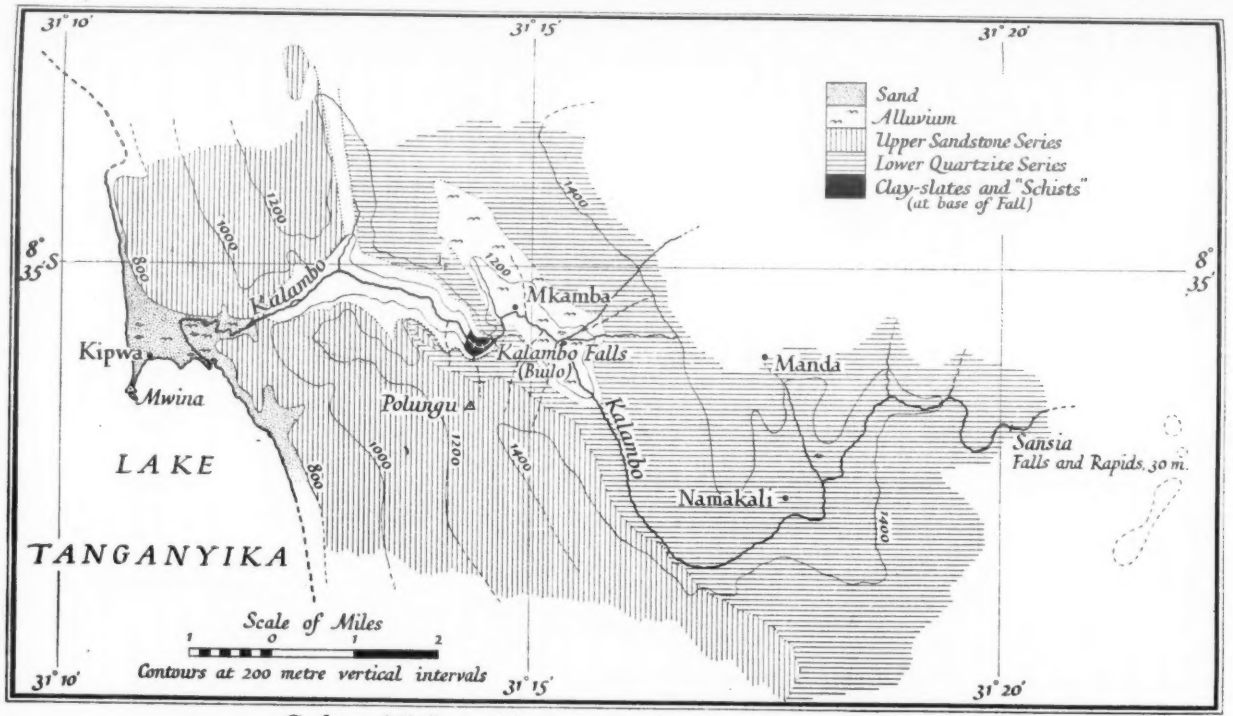
COLIN ROSE

IT was with great expectations and some considerable excitement that I left England with Mrs. Gordon-Gallien and Mr. Cornwall for Tanganyika, as geologist to this interesting expedition to the Kalambo falls, and in no respect was I disappointed.

Our stay at Kalambo lasted about six weeks, in camp literally on the lip of the falls themselves, and even now, when everything is over, questions arise which can only be answered standing on those bare rocks of the lip, where the whole story is displayed at one's feet. I would consequently ask you this evening to accompany me on a short excursion up the Kalambo river, just as we went up it six months ago.

It will be seen from the map that the highest point upstream we reached was called Sansia, and it is from here that it will be most convenient to start, working downstream all the time and finishing at the great Kalambo gorge itself.

The river has its origin about 30 miles inland from lake Tanganyika, probably rising in some ancient volcanic hills whose denuded summits could be seen from such a hill as Kiungu, described by Mr. Cornwall, and it is after traversing some 30 to 40 miles of forest-clad plateau country that it is seen at Sansia as a swiftly flowing torrent, occupying a small and immature valley. A mile or two downstream the river sweeps round a long ridge, with the small native village of Namakali at its end, and overlooking the river. From Namakali the path to the Kalambo falls leaves the river, making a short cut over the next ridge, rejoining it again quite near the falls. The river, however, continues, over rapids for the most part, until it reaches the great escarpment of Kiungu, which runs south-south-east from Kalambo towards Abercorn in Northern Rhodesia. Here the river takes a sharp bend northwards, and runs along at the foot of the scarp, gradually entering a wide and more mature-



Geology of Kalambo District: region left blank in gorge inaccessible

looking valley. It is joined by at least three small tributaries on the eastern side, among which is the Vundwi, which flows through the small village of that name lying nearly at the summit of Burnt Ridge. It was at Vundwi that we made the acquaintance of Johnny Kipondo and his large family. Johnny came to see us when we first arrived at Kalambo, and was obviously jealous of the self-appointed guide Kanuka. Kanuka claimed to be Lord Kalambo Falls, so Johnny, not to be outdone, said that the falls beyond his village were far bigger than these here (*i.e.* Kalambo), and he suggested that we should transfer our activities to Sansia, when he could then be Lord Sansia Falls.

Here, however, I must digress a little, and give you some idea of the lie of the land. The greater part of Tanganyika is composed of hard crystalline rocks, whose origin is still rather obscure. They form part of the ancient African massif which is generally supposed to be of Achean or Pre-Cambrian age. No evidence is known which proves that these rocks have ever been completely submerged beneath the waters of the sea. In some places, however, we find deposits that have accumulated in the hollows and depressions of the older rocks on which they rest. These rocks have every appearance of normal sediments such as we are familiar with in England, but on closer examination they are found to be false-bedded, ripple-marked, and so forth; also they contain no traces of former life. These facts all lead us to believe that these *sedimentary* rocks were accumulated within a continental mass, and they constitute the weathered fragments and material derived by the disintegration of the older crystalline block. Such a series of rocks is exposed in the neighbourhood of Kalambo gorge, and gives rise to the Kalambo fall itself.

Generally speaking, the country consists of a series of parallel ridges running roughly south-south-east to north-north-west. The various layers of sandstone and quartzite are grouped one above the other, and the whole pile then gently tilted to the west-south-west. Each bed as it reaches the surface forms a ridge, the steep escarpment side of which faces east-north-east.

In the vicinity of the Kalambo falls themselves, and in the gorge below, however, this apparent harmony has been disturbed. Earth-movements have arched up the rocks about an axis which runs north-north-west to south-south-east along the gorge, and during the process several small faults have been initiated along the path of the disturbance. In two places, too small to be recorded on the map, dykes of igneous rock—quartz-dolerite—are exposed at the surface, no doubt a subsequent effect of the movement. The rocks themselves are interesting inasmuch as they contain a great variety of lithological types; sandstones and quartzites of many hues predominate, but archoses, conglomerates, and grits, with finer bands of hard shale, can be recognized, while a bed of variegated chert is very conspicuous. There is no limestone.

Tornau, a German geologist, in his paper on the Geology of Middle and Western parts of Tanganyika, refers to this great sandstone series developed round the southern end of Lake Tanganyika, and his descriptions compare quite well with these rocks of Kalambo. They are referred by him to the "Tanganyika System," and have been correlated by F. Behrend, another German observer, with the Transvaal or Potchefstroom System of Union of South Africa, the Karagwe Series of Kenya Colony, and the Kundelungu

System of the Belgian Congo; their age, as far as can be stated definitely, is probably Pre-Devonian. This short geological sketch will enable us to understand more clearly the structure of the Kalambo fall, to which I will now turn.

Between the long ridge called by us Burnt Ridge and the ridge which marks the edge of the gorge, there lies a long shallow depression which forms such a prominent feature on the map. The surface of the ground is flat, and the vegetation dense scrub, in marked contrast to the abrupt hills and forest elsewhere. The Kalambo river lazily finds its way through this patch of soft deposits of alluvial material.

It is here wherein lies the key to the origin of the Kalambo falls. This small area of about 2½ miles long by 1 mile wide marks the site of an old lake that has been formed when earth-movements caused a flooding of the old Kalambo system. This lake grew and grew, leaving its tell-tale deposit of alluvium behind it, and eventually the river broke out, cutting itself a new course through the massive rocks of the gorge region, to find a quick outlet to lake Tanganyika.

The story of the Great Rift Valley System of Africa, as discovered by Prof. J. W. Gregory (now President of the Geological Society), needs no mention here—it is too well known—but that the main Rift Valley faulting and vertical movement are associated with the uplift at Kalambo I think there can be no doubt. A general uplift of the whole region would, I think, explain everything, and that a relative movement of this kind has occurred is, of course, the essence of the Rift Valley theory.

The sandstones of the Kalambo gorge are mostly massive; they are well jointed, and during the uplift these joints have been enlarged. An additional strain has been imposed upon them by virtue of the anticlinal axis running across the gorge, and influenced by these lines of weakness the Kalambo finds a new outlet. Fortunately for us, the river has to fall some 1000 feet before it reaches the end of its course, lake Tanganyika, and now the river is rapidly carving itself a new system, and seeking to establish a new base-level of erosion.

That this uplift has been repeated at least once is shown by the fact that every valley which enters the gorge below the fall is overdeepened, and its entrance is marked either by falls or by very steep rapids. We can summarize the whole effect as follows: first a general uplift of the whole region, probably a direct cause of the anticline of the gorge (which was thus subjected to strain) and the flooding of the old Kalambo System, the overflow from the temporary lake thus formed being by way of the gorge, so that the river began to carve itself a new course: secondly, further uplift or uplifts which increased the gradients of all the streams, including the Kalambo, draining into the gorge area, with the effect that every stream has been rejuvenated, and they are beginning to cut new valleys in the bottoms of their old ones.

The beginning of the final stage of the river's journey to the lake is marked by a large bend in the valley above the fall, and it cuts a small gorge in the ridge just behind our camp before it takes the final plunge. Immediately above the fall the Kalambo is a placid river gently flowing through a glade of tall trees in which baboons are always to be seen swinging from bough to bough; nothing could be more peaceful. Then the trees give way to a few yards of bare rock, and the river disappears in a foaming torrent, to tumble 700 feet to

the gorge below—a sheer drop, with no break whatsoever. On either side the cliffs rise to nearly 1000 feet, and the fall is so cunningly tucked away in the corner of the chasm that it seems ridiculous that such an innocent-looking river could be guilty of such wanton mutilation of the landscape.

The effect of joints and fissures in the hard sandstones and quartzites is strikingly seen in Chasm Cliff, which must be due to the influence of a master joint or fissure which has been enlarged and worked out by the eroding force of the water. At the lip of the falls the river works down from a softer bed of argillaceous character to the hard pink quartzite already referred to and flows over the lip in a small sunken channel carved out along the bedding planes and joints of the rock. On either side it is possible to climb down the cliff face for several feet by means of natural steps.

During the period of our stay at Kalambo the width of the water over the lip varied from about 20 to 15 feet, and it was rapidly becoming smaller when we left; but it shows every indication of widening to 60 feet or more after the rains. The rough bridge we built for convenience just over the pool behind will thus stand little chance against the raging torrents caused by the African rains.

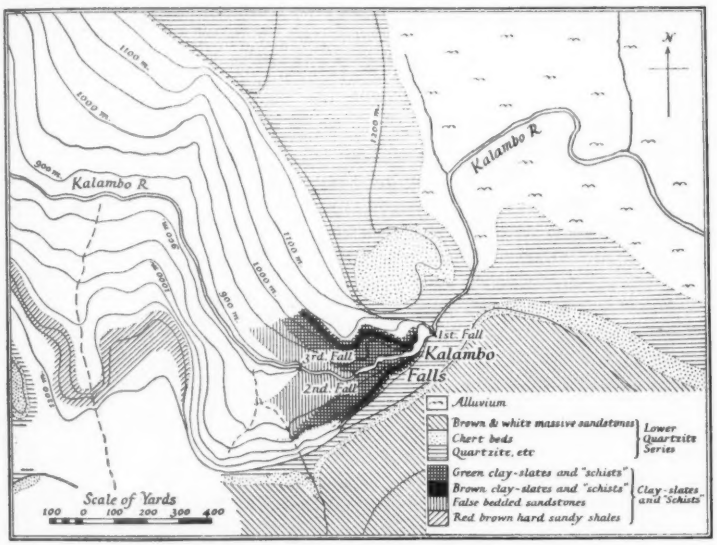
By lying flat and peering over the edge, the pool at the bottom can be distinctly seen, but all idea of size is lost: it is as if one sees a New World displayed at a dizzy depth below. On making the tedious descent to the base of the gorge, the fall is seen from an entirely different aspect, and the magnitude of the drop becomes much more of a reality. The climb down is difficult in parts, but was negotiated several times by us, and the scene at the base amply repays the time and labour spent in the operation. The river is struck at a point where it emerges in a succession of rapids from the pool at the base of the fall, but the pool itself is invisible from this point, being hidden behind a high spur of rock. The atmosphere is thick with spray, and everything is dripping wet, so to climb about the slippery rocks to see the pool needs considerable care. Any attempt to get a good photograph is likewise useless, and the only one we got of it was obtained by wading across the rapids and climbing some distance up the cliff on the Rhodesian side. The vegetation is everywhere luxuriant, and must be of a peculiar type flourishing as it does in an atmosphere of perpetual rain.

It is interesting to note that, while sandstones are the rule at the top of the gorge, clay-rocks are developed here. They are chiefly dark green in colour, and although much hardened and crushed subsequent to their deposition, they are soft compared with the iron-like consistency of the rocks above them. This phenomenon of a hard rock resting upon a relatively soft one will cause differential erosion, and is the basic cause of most waterfalls. The fact that the rocks are dipping markedly upstream and that they are composed of alternate relative hard and soft layers is one reason why there are two further falls below the main one. The presence of these had been suspected, but their position was somewhat doubtful.

The first one can only be seen from the Rhodesian side, and lies about 200 yards below the base of the main fall. The approach is by deep, narrow rapids, and the water falls eventually about 50 feet into a gorge whose walls rise sheer for 100 feet, and which is only about 3 yards wide. It is situated in

such a position that it is impossible to obtain a photograph of the fall itself. We immediately considered the possibility of striking the river farther downstream and working up to the fall, and it was in attempting to do this that the second minor fall was discovered. Again the river rushes between great boulders, and then pitches over an edge to drop 27 feet into a gorge as narrow and as sheer as the last. By fording the rapids we managed to obtain a photograph, but the result was poor. Owing to precipitous and greasy slopes, and the perpendicular walls of this small gorge, we were compelled to abandon all thoughts of working upstream to the main pool.

Our expeditions to the base of the fall were always full of excitement, and Kanuka, who invariably accompanied us, demanded an exorbitant fee after



Detailed geology of Kalambo Falls

every successful venture. We decided that such a thing could not continue for ever, and our last trip to the bottom was without Kanuka, he having flatly refused to come when there was no prospect of a reward at the finish.

The final lap of the Kalambo's journey to the lake, from the base of this last small fall, is a series of rapids and whirlpools, as the river rushes along the bottom of the immense gorge which towers above it on both sides. Viewed from such eminences as Precipice Point or Bald Head, two immense spurs overlooking the river from a height of 700 or 800 feet, the river appears as a mere streamlet. When still about a mile from the lake, the river slowly meanders over an alluvial flat, and eventually finds its way through its small delta to merge with the waters of lake Tanganyika. In this region of long grass and rushes the hippopotamus hides, and may sometimes be seen in the deeper pools which lie just behind the lake-shore.

During the course of our stay at Kalambo I found plenty to do. The main difficulty on the geological side was the scarcity of exposures of rock. Practically speaking the only natural sections were those in the sheer faces of the gorge itself, and these, of course, were mostly inaccessible. I should like to say how extremely useful it is to be able to get a bird's-eye view of the country from the top of a tree when thick forest obscures everything on the ground. Mrs. Gordon-Gallien and Mr. Cornwall will bear me out when I say that some considerable portion of my time was spent aloft with the baboons, while a platform built at the top of an immense tree in our camp proved an invaluable help in many ways.

Of our journey home by car Mrs. Gordon-Gallien has already spoken, and time forbids me to describe the many features of geological interest that we encountered during that memorable seven days' run. I think perhaps crossing the Southern Highlands of Tanganyika was the most interesting, and the sight of the Great Rift Valley lying at our feet will always stand vividly in my memory, while the final run through the mountains between Iringa and Kilosa was a fitting climax, not only to that adventurous journey by car, but to the Kalambo Falls Expedition.

DISCUSSION

Before the paper the PRESIDENT (Col. Sir CHARLES CLOSE) said: Mrs. Gordon-Gallien, who is going to address us to-night, is a very accomplished traveller. I shall give you an idea of her prowess in travelling when I say she drove her car across the desert to Baghdad and back. Mrs. Gordon-Gallien was determined to be even more accomplished, and she took lessons under Mr. Reeves, of this Society. She took lessons, I think, in 1925, and again with her husband in 1928. Then, after a prolonged course of instruction in surveying and field astronomy—a subject quite familiar to everybody present—Mrs. Gordon-Gallien asked me, "Now, what can I do? How can I help the Society? What sort of exploration can I carry out?" It occurred to me that there was at least one piece of work in the middle of Africa which deserved to be done, and that was a complete and thorough exploration of the falls of the Kalambo river, which is the frontier of what used to be German East Africa, and flows into the south-eastern portion of lake Tanganyika. When I was settling that frontier rather more than thirty years ago the falls were somehow missed. Years later it was discovered that there was this magnificent waterfall which Mrs. Gordon-Gallien is to tell us about. When she went out she was accompanied by Mr. Cornwall, of the Royal Artillery, who, to a large extent, carried out the survey work, and Mr. Colin Rose, who is a geologist. You will realize that it was a very complete expedition, and I think that we shall know when we hear Mrs. Gordon-Gallien all that is to be known about the Kalambo falls. I am sure that there never was an expedition which did more thoroughly the job of work it set out to do. I now ask Mrs. Gordon-Gallien to tell us all she knows about the Kalambo falls.

Mrs. Gordon-Gallien, Mr. Cornwall and Mr. Rose then read the papers printed above, and a discussion followed.

The PRESIDENT: I have a note written by Mr. W. E. M. Owen, who is unable to be present owing to illness. He first heard of the falls in 1908, but did not see them until 1913, when he took photographs. Copies of the photographs were obtained by Mr. Scott Brown, who was shortly afterwards taken prisoner in German East Africa on the outbreak of war and died as a result of hardship.

Kalambo Gorge and lip of Falls

Mouth of Kalambo : Mwina trig. point

Kipwa village on Mwina spit

Sansia Falls

Kalambo Gorge

The pictures came into the possession of his widow, and one of them was published in the *Geographical Journal* for January 1926 in the belief that it had been taken by Mr. Scott Brown, whereas it was really taken by Mr. Owen.

I do not know whether Mr. Melland is present. If so, we should be glad to hear a few words from him. He may have photographed the falls some years earlier than Mr. Owen.

Mr. F. H. MELLAND: I am one of those to whom reference has been made, namely, the travellers who have visited the Kalambo falls and made wild estimates as to their height; but I am glad to say that my estimate, which was put on record about twenty years ago, is fairly accurate. I described the falls as being between 700 and 800 feet high, but I think it might be said that the mere matter of feet conveys very little to most people. If the falls were 800 feet they would be about twice the height of the Victoria Falls at the other end of Northern Rhodesia. That gives some idea of their height to most people, because everybody is familiar with the Victoria Falls—in pictures, at any rate.

I believe I was the first to photograph the Kalambo falls, showing their full height from top to bottom. That photograph was taken from the Chasm Cliff. The falls are a most wonderful sight; certainly a sight never to be forgotten. As we have heard so much about the Kalambo falls and such interesting details, it would be futile for one who has only spent a couple of days there—and that long ago—to attempt to say more. I should, however, like to call attention to the number of waterfalls there are in Northern Rhodesia. There are the Kalambo falls at one end and the Victoria Falls at the other, but throughout the country there is a succession of falls of great height and, in some cases, of great volume. Many have not been even inaccurately mapped; that is to say, we have them on sketch-maps, but there appears to be no record of them in England. I am thinking of two in particular, the Luchenene and Mtinondo rivers, both considerably bigger than the Kalambo, that fall down the Muchinga escarpment some 3000 feet into the Loangwa valley, not in one fall but in a series. There is also the Chishimba, near Kasama, which looks like the Victoria Falls in miniature, a river of considerable size. In fact, falls are dotted throughout the country, and there is no doubt that at some time in the near future they are going to be not only things of beauty but of great value to the territory. At some time railway development will take place in those countries. The Dodoma—Fife—Broken Hill line, for instance, has been considered, and there are other possible railways. These lines will cost a great deal to construct, and the running costs will be exceedingly heavy if coal is to be used, because there is none, so far as we know, in this area, and one cannot depend on the wood supply for very long, even in Africa, so the use of electricity must be seriously considered. It has been proved in Natal that long-distance railways can be satisfactorily run by electric power, and the value of hydro-electric power has also been proved locally at Broken Hill. A pipe-line goes down 800 feet and power is carried to Broken Hill Mine, a matter of 35 to 40 miles, overhead.

If an accurate survey were made of the waterfalls in this part of Africa (Northern Rhodesia) now, not in a rush at the last moment but more on the lines of the work done at Kalambo falls, it would be a great help when serious consideration came to be given to the construction of railways, which are so necessary, and which will become increasingly necessary, for the development of Africa.

One of the faults we have in the development of our Empire is the habit of leaving everything to the last moment, so that when we want to get really going everything has to be done in a rush, and money is wasted. It would be an easy matter to-day for the Governments concerned to make an accurate census of the

waterfalls; get them properly mapped and heights correctly measured, and everything done, so that when the railways come to be made it could be seen what power was available. Further, the old methods in mining are fast disappearing, and nowadays the electrolytic treatment of copper has completely revolutionized the copper industry, with the result that in a few years Northern Rhodesia will produce the 180,000 tons of copper a year that Great Britain requires. That will demand an enormous amount of power, so that the value of the waterfalls within reach of mines as well as of railways is going to be considerable.

There is one other little point about waterfalls that frequently escapes general notice. In the settlement of Africa great attention is being paid to setting aside certain areas for native reserves. One has to be careful not to cut off in these reserves the supply of electric power not only for power stations but for running overhead wires necessary from the power stations to wherever the power is needed. If only the same work could be done in regard to the other waterfalls as has now been done at Kalambo, it would be a great help in the development of Africa, and we should be very grateful to the lecturer for the excellent example which she has set.

The PRESIDENT: The Society is grateful to Mrs. Gordon-Gallien and to her companions for the work they have done. As the last speaker has said, this sort of investigation is important from a national and Imperial point of view. I should like to explain that Mrs. Gordon-Gallien paid the whole cost of the expedition.

It has been of very great interest to me to see the photographs of the Kalambo falls and to hear the account of the expedition and the way in which positions were fixed, because when I was in the neighbourhood rather more than thirty years ago no white man knew there were any such falls. I had an opportunity of talking with the few white men on Tanganyika territory at the time, and I sent an expedition down the Kalambo river to make a map of the river, but they happened to miss the falls. That might happen to any expedition. But the expedition of which we have heard to-night did not miss the falls; on the contrary, we have the most admirable contribution to our knowledge of that country which it has been my good fortune to hear for a long time. I am convinced that those who, in the future, study this important question of the water-power of Africa will look upon Mrs. Gordon-Gallien's expedition as a landmark in the history of that problem.

ECHO SOUNDING : *A paper read at the Afternoon Meeting of the Society on* 11 *March* 1929, *by the Hydrographer of the Navy*

REAR-ADMIRAL H. P. DOUGLAS

IN recent years an ingenious and original method of ascertaining the depth of the sea has been gradually evolved. This is commonly known as Echo or Sonic sounding, and will doubtless almost entirely supersede the lead and line, which in variously improved forms, conforming with the advance of machinery, have been in use since ships first went to sea. The method is based on the theory of the propagation of sound by waves and the reflection of these waves on striking a different medium. In short, a sound is emitted from a ship, is reflected from the bottom of the sea and received back in a hydrophone. The time of this double journey is measured; and the speed of sound in water being known, this interval is convertible into a distance, half of which, after the application of minor corrections for the separation of the transmitter and hydrophone, is the depth of water under the ship.

Sound in water, however, travels at approximately 4800 feet per second, which, to take an example, means that in 10 fathoms the interval of time to be measured is in the neighbourhood of one-fortieth of a second. That instruments have been designed to measure these extremely short intervals with the precision necessary is the result of a number of years of effort and experiment and the ingenuity of the designers.

I will give brief descriptions of the different ways in which acoustic echoes can be used for measuring the depth of water beneath a vessel, and will indicate what measure of success has been reached in practical instruments which have been produced, and which employ different elementary principles.

The most direct, and also most obvious way of finding the depth of water is to measure the time which elapses between the emission of an impulse by a transmitter, fitted in a ship, and the reception of the echo. If the velocity of sound in sea-water is v, and the measured time-interval is t, then the depth of water is $\frac{1}{2}vt$, since the time-interval measured is that taken of the double journey from the ship to the bottom and back again. Simple corrections can be made to this formula to take into account the effect of the separation of the transmitter and receiver, which is of importance only in very shallow water, and the effect of variations in the velocity of sound due to temperature, salinity, etc.

Most practical forms of echo-sounding apparatus have been based on this principle, and the points which are of interest to us now lie in the kind of apparatus used for the measurement of time. What is required is some instrument which will record time-intervals simply and reliably. It is obvious that, since the depth is directly related to the time-interval, the instrument which records time may be graduated to read depth direct. This is done in the Admiralty pattern echo-sounder, in which the scale readings are in fathoms and not in seconds.

The American Submarine Signal Co.'s Fathometer also works on the same principle as the Admiralty apparatus. The transmitter, originally electromagnetic, has recently been altered to a hammer type, and the receiver, though it works in a manner similar to the Admiralty type, gives a visual indication

of the depth by causing a small light, which moves against the depth scale, to flash. This apparatus has proved very accurate and useful in the measurement of great depths of water, but I believe that it has not so far been used successfully in shallow water. The reason for this lies possibly in the fact that, with electromagnetic transmitters, it is less easy to obtain a short sharp shock than with specially designed transmitters. The question of screening the receiver from the direct effect of the transmitter is also more important in shallow water than in deep, because only a very short time-interval elapses between the operation of the transmitter and the return of the echo. During this short time the receiver must be able to recover from the effects of the impulse due to the original transmitted sound.

The German Behm apparatus also depends upon the recording of time-intervals; but here we have, as a time recorder, a small spring-driven motor which is started and stopped, by an electrically controlled release and brake, when the impulse from the transmitter goes out and the echo returns. Small explosive charges are used as a source of sound, and are fired into the water from a special small gun. In the instruments I have seen, the adjustment of the starting and stopping arrangements was a delicate operation, and I am not convinced that they are sufficiently robust for prolonged operation without specially skilled attention. For survey work the expenditure on explosive charges could not fail to be considerable when it is a question of taking many thousands of soundings.

In the various forms of sounding apparatus so far described, the sources of sound have all been audible or "sonic." In the French apparatus of Langevin, which is manufactured by the Société de Condensation et d'Applications Mécaniques, the source of sound is a transmitter consisting of plates of quartz, exposed to the water, which are set into oscillation electrically by what is called the "piezo-electric effect." I do not propose to go into the theory of this effect because all that concerns us here is to know that such a transmitter is capable of producing vibrations in water of such high frequency as to be inaudible. At the same time, owing to the high frequency, the sound goes out from the transmitter in the form of a beam, like a searchlight beam, instead of spreading in all directions. The advantage of this beam lies in the possibility of detecting comparatively small obstructions beneath the water when they are not too deeply submerged. Small projections such as wrecks may be missed by ordinary echo-sounding apparatus, which tends to give an average depth over an area rather than the absolute depth at a point directly below the ship. For navigational purposes it is, of course, important to have warning in advance of the presence of an obstruction. This the sonic apparatus does automatically, while high-frequency apparatus, such as the Langevin, only gives the distance of an obstacle which is more or less in the direction of the beam. I believe that the Langevin apparatus has distinct possibilities for special purposes, *e.g.* for locating wrecks and other comparatively small obstructions, but that it is too costly and complicated for ordinary navigational use and even for hydrographic survey work.

It is also possible, at least in theory, to measure depths by making records of the intensity of the echo which comes back from the bottom of the sea—the deeper the water, the fainter the echo which comes back. I am aware that

apparatus based on this principle has been made and tried abroad, but, while it is obvious that it might work if the sea-bed was always uniform, say, of flat rock or sand, I cannot understand how it could give accurate results in two different places where the character of the ... on was not the same. The reason for my doubt of the reliability of this system of depth recording is based upon the knowledge that the reflecting pow... r of mud is very much less than that of rock or sand, and a change from one ... terial to another could not fail to introduce errors into the depth readings.

A third principle, which has been worked upon in the United States, depends upon having a transmitter fixed, say, in the bottom of the forepart of a ship and a receiver in the afterpart. Sounds given to the water by the transmitter will be reflected from the bottom and will arrive at the receiver making an angle with the keel of the ship. This angle clearly depends upon the depth of the water and the distance between the transmitter and receiver. The angle is measured by a most ingenious electrical sound receiver which takes account of the direction of the reflected sound coming from the bottom and is capable of giving an accurate estimate of the depth when the water is shallow. When the depth is great compared with the length of the ship, the accuracy cannot be as great as we should wish, because of the difficulty of measuring the angle of arrival of the sound waves with extreme precision. This apparatus, though most ingenious, is in my opinion inferior, from a practical point of view, to the simpler and more accurate instruments which depend upon the measurement of time-intervals.

Briefly described, the British instrument has for its source of sound a steel diaphragm, fixed to the hull of the ship, and this is set in vibration by a small spring hammer which is withdrawn at regular intervals from the diaphragm by a solenoid. A simple microphone, enclosed in a carefully designed rubber body and compartment, forms the receiving hydrophone. A 1/8 horse-power motor, running at 1800 revolutions per minute, drives two switches through a 10 to 1 reduction gear. These switches consist of brushes bearing on a rotating disc with insulated segments. One of them breaks the circuit to the solenoid of the transmitter three times a second for about 0·0025 second, whilst the other, running on the same shaft, short circuits the telephone in the receiving circuit, except as determined by the position, relative to the corresponding pair of brushes, of a second insulating segment. This latter pair of brushes can be displaced by a hand wheel, and if a sound is heard in the telephone we know that the time taken for the insulated segment of the disc to travel the amount of the displacement must be the same as that taken by the transmitted sound to travel to the bottom and back to the receiver. The velocity of sound in water and of the revolution of the switches being known, it is possible to graduate this displacement of the brushes in terms of the depth in fathoms, and this is done on a circular scale on the hand wheel. It is clear that the speed of the motor is all-important, and a specially designed centrifugal governor controls it to a constancy of 1 per cent., despite variations in the supply voltage.

This having been successfully accomplished, let us turn to the consideration of another problem that had to be met. It was due to the response by the receiver to the waves emitted directly from the transmitter, besides those

echoed from the bottom. Owing to the shortness of time that is taken by the echo to return in shallow water the receiver must be able to recover very rapidly, and to effect this the transmitter must not be one that sends out waves

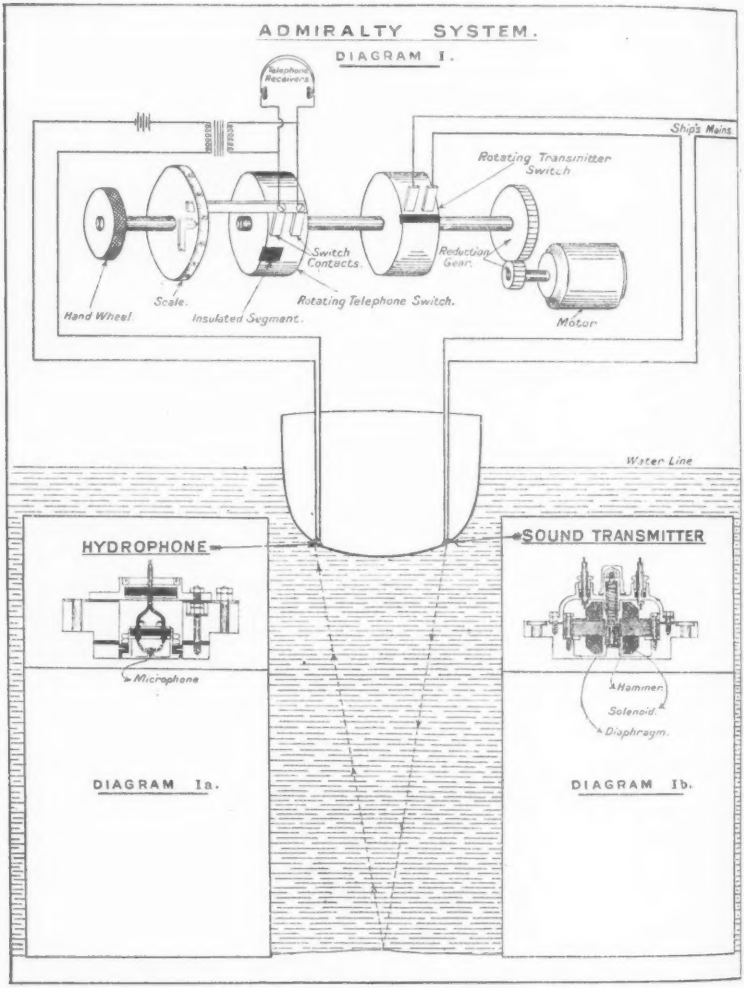


Diagram of Admiralty pattern Echo-Sounding Gear, Shallow-water Type, Mark II, from Admiralty Handbook (H.D. 279), 1926

of considerable duration in time. For this reason, the Admiralty concentrated their efforts upon the production of an entirely new type of transmitter in

which the impulse should be intense and yet last for an exceedingly short time. The result was a diaphragm which receives its impulse from a small hammer, and it has been found possible to measure the depth of water when it is only just enough to float the ship. This shows that the receiver must be " dead " after a very short time.

Another method of lessening the impulses that are transmitted by the water directly to the receiver is by the suitable placing of the latter with reference to the transmitter. Were they to be mounted close to one another in the bottom of the ship, the amount of energy absorbed by the receiver would, in shallow water, render it insensitive to the returning echo.

In actual practice the relative positions of transmitter and receiver are chosen specially for different ships, the guiding principle being one to minimize as far as possible the energy that passes directly between them. This is accomplished by mounting them on opposite sides of the ship with their diaphragms inclined to the horizontal 20° to 30°. This does not greatly diminish the amount of energy which goes directly from the transmitter to the bottom, since the transmitter has no marked directional properties, but it does result in a very greatly decreased amount being transmitted directly through the water to the receiver on the other side of the ship.

Certain difficulties were encountered in fitting the first ships, and these were due to our lack of experience in choosing the most suitable positions for each new type of vessel. The conditions which had to be fulfilled to get the best results were not fully understood, but once they had been determined for any particular ship, it was possible to fit further ships of the same class in the full knowledge that the results would be satisfactory.

Other difficulties apart from those connected with the choosing of the proper positions for the transmitter and receiver, were encountered with the early sets under sea-going conditions; they were those which are common to all newly designed devices. It is impossible, in first instruments of this kind, to avoid such things as the working loose of bolts, breakdown of insulation, wearing out of parts, and other minor defects due to faults in design. Added to this is the fact that they were fitted to ships in which the wear and tear was as great in a week as it would be in a year in a merchant ship during the ordinary course of navigation.

It has often been suggested that a machine which is able to produce sufficient energy to give an appreciable echo in 200 fathoms of water must be a very noisy shipmate. This suggestion is based, I presume, largely on the experience of everyday life, but one has to remember that in water sound travels with a very much smaller dissipation than it does in air, and consequently we are able to get satisfactory echoes with a comparatively weak source of sound. The vibrations of the diaphragm which are set up by the hammer are not conveyed to any considerable extent to distant parts of the ship through the hull plating or internal structure, because the diaphragm is mounted in a heavy ring which acts as a sound insulator. Most of the sound energy is transmitted direct to the water, and its source does not cause annoyance in the ship.

The scientific side is one concerned chiefly with the path and progress of the sound waves in the water, and is bound up with the consideration of the

degree of accuracy required. For navigational purposes an accuracy of 1 part in 300 is ample. Such soundings are nearly always taken on the continental shelf, which in most parts of the world means inside the 100-fathom line. In such depths a vessel is not far from the land, and owing to the gentle and regular slopes a line of soundings gives the maximum of information. The depths are entered on the chart to the nearest fathom, and if they are correct to 1 in 300 any error will not affect the unit place. Outside the continental shelf lies the narrow, steeper continental slope which dips from the edge of the shelf to the bottom of the sea in 1000 or 2000 fathoms. It is not likely that this will ever be sounded with great accuracy, and there is good reason to believe that it is so irregular and narrow that an error of 1 in 30 would not make much difference to the resulting fix. As for sounding in the deep sea, it is hardly likely that a ship would be so far uncertain of her position that a sounding on the long, gentle slopes of the bottom would be of much assistance. An exception must be made in the case of cable-laying, where a knowledge of the depth is of great importance in order that the cable may be paid out at the correct rate.

In the case of soundings made for scientific purposes a higher degree of accuracy, or perhaps relative accuracy, might be desirable in shallow water.

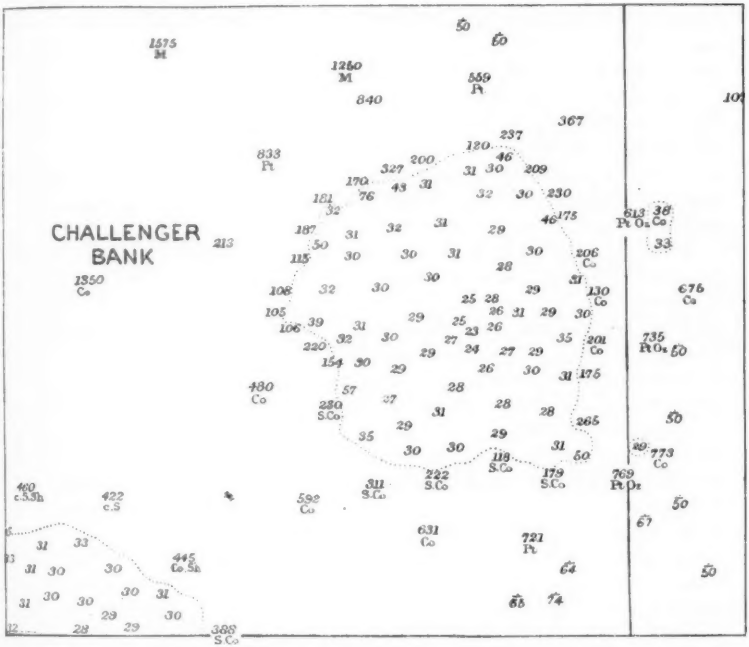
It is not possible to check an echo sounding in deep water by means of a wire sounding, since we do not know whether the wire is straight up and down. Good agreement has, however, been obtained between the observed horizontal velocity and the velocity calculated on theoretical grounds by means of the Admiralty " Tables of the Velocity of Sound in Pure Water and Sea Water for use in Echo Sounding and Sound Ranging," from the properties of sea-water determined in the laboratory, and the temperature and salinity in the sea at the time of the experiment. In the Straits of Dover the difference varied from 1 in 700 under unfavourable conditions in the winter to less than 1 in 15,000 under favourable summer conditions. This last close agreement, even though the average of a number of experiments, is of course pure chance. There is no reason to suppose that the agreement would be very much worse in deep water, and there is therefore every probability that the Tables are correct to 1 in 300 at all depths.

The method of computing the velocities is given in the Tables, and there is no reason to repeat it here. It will be sufficient to extract some figures showing the effect of an error in the assumed temperature and salinity. At 0° C. and atmospheric pressure an error of 1° C. would cause an error 4·6 metres per second in the velocity; at 5° C. the error would be 4·1 metres per second; and at 30° C. 2·1 metres per second. These correspond to 1 in 314, 1 in 358, and 1 in 735 respectively. Great depths have little effect on these errors: at 8000 metres, or 4374 fathoms, the error in the velocity and therefore the sounding would be 1 in 289. With modern reversing thermometers an accuracy of a few hundreds of a degree is easily attained, and once the average vertical temperature distribution has been determined there should not be any difficulty in reaching an accuracy of 1 in 300 in the depth. The effect of an error in the salinity is far less; it would have to be a very large error to cause an error of 1 in 3000 in the sounding.

A knowledge of the temperature and salinity in the different oceans is of

course necessary. We already have this for many places, and a recent *Admiralty Notice to Mariners* draws attention to the necessity of soundings taken by the Admiralty pattern Echo-Sounder in the Red Sea having a 5 per cent. correction applied. It is not thought that this amount will be exceeded, and in the majority of seas the correction will probably be too small to be of interest to the navigator.

The advantages of the Echo method of sounding are apparent. By making



Soundings on the Challenger Bank from Admiralty Chart No. 360. Scale 5 sea miles = 1·8 inches

a switch to start the mechanism and listening a few moments in the head-phones for the echo, the captain or officer of the watch is able to determine the depth of water under the ship; there is no leadsman to place or sounding machine to rig. Navigation in fog is made easier and the surveying ship's output vastly increased.

Take the case of the survey of the Challenger Bank, south-west of Bermuda, in May 1925. The Officer in Charge of Survey reported that it would have been completed in half the time by the echo, compared with the lead-and-line method, but for the fact that these being early days of the apparatus, some of the lines of soundings were run using both methods to check their agreement. He remarked that it was at once noticed when the ship arrived from deep water into 35 or 40 fathoms, and vice versa, and the edge of the bank was

detected before any up-and-down sounding could be obtained by the lead and line. He also pointed out that the apparatus on some days ran almost continuously for a period of eight hours, and that it was not until the last day that a minor mechanical breakdown necessitated the temporary stopping of the machine.

To ships concerned with oceanic depths at the present time, such as surveying, cable-laying, and those on scientific expeditions, echo-sounding means that a sounding of say 2000 fathoms can be determined in a matter of seconds, instead of the hour that a lead would take to reach the bottom and be hove in again. Unfortunately for the geologist and oceanographer, the echo does not return with a specimen of the bottom.

This Admiralty pattern was designed by the Admiralty Research Department and fitted first to the Surveying Service in 1924. Minor modifications and improvements followed as the result of experience in its use, and in 1925 the manufacture of the instruments by Messrs. Hughes & Son under licence from the Admiralty commenced. The M.V. *Asturias*, the first of the Merchant Navy, was fitted in that year.

At the present time Shallow Water and Oceanic types are made, the former being sub-divided into three "Marks" or "Designs": Mark 2, the first type to be fitted, reads to 135 fathoms, Mark 3 to 250, and Mark 4 to 500. The Oceanic type is suitable for depths from 30 to 4500 fathoms. Similar principles underlie the various types, and one of the main differences of the Oceanic type from that described lies in the transmitter, which instead of employing a spring-loaded hammer is actuated by a pneumatic one.

The accuracy obtained with the British Admiralty shallow-water apparatus is all that is required, and its proved reliability in continuous use is a result of its extreme simplicity. Eight or ten hours a day continuous running during the outdoor season has been successfully undertaken by these instruments in H.M. Surveying Ships during the last few years, and testimony to their accuracy is given by the officers of the Port of London Authority in their yacht *St. Katherine*. The work carried out by them in the Thames Estuary requires exactness in the sounding of dredged channels, and to detect the gradual changes in the banks; and their claim is to an error of only 6 inches in depths of 10 to 15 fathoms.

The cost is another point in its favour: for the Mark 2 Shallow Water type £300, and £50 for the fitting. Nowadays it is not necessary to cut the hull of a ship for placing the hydrophone and transmitter, as this is done internally. Improved design has made this possible, and at the same time increased the efficiency of the receiving microphone.

Difficulties were met with in 1925 in the M.V. *Asturias*, the first mercantile vessel to be fitted, but experience and experiment have overcome them. The trouble was found to be due largely to air bubbles and pockets on the skin of the ship, and this has been overcome by having regard to the shape and design of a ship's bottom, when deciding on the positions for the hydrophone and transmitter.

Since that date increasing numbers of ships have been fitted, despite the conservatism of the sailor and his inclination to look askance at any new-fangled invention. This it is that has no doubt restricted the instalment of the

instruments to the better-known, up-to-date steamships; but there is no reason why the tramp too should not be fitted for the comfort of her master, and, more important, the safety of the ship in thick weather.

H.M. ships of all classes, from H.M.S. *Nelson* to a sloop, carry this apparatus, and the Royal Australian Navy has also vessels fitted. Foreign navies using it are the Argentine, Spanish, Russian, Dutch, and Chilean. Its value in submarines has also been proved.

The Merchant Navy list of ships fitted contains ships of the Royal Mail, Union Castle, Orient, P. and O., whilst two of the Blue Funnel Fleet are now being fitted.

The two cable ships *Dominia* and *Faraday* have the deep-water apparatus, as also has the Italian *Citta di Milano*. The oceanographic work of the latter is a proof of the value of the instrument to her, and in 1926 the *Dominia* successfully obtained soundings in well over 3000 fathoms. Recent modifications from the experience gained in these ships have improved this type.

We finally come to a totally different class of vessel, the trawler, of which vessels fifteen have now been fitted, and we find the echo-sounder proving its value to the fishing industry. Apart from its assistance to the trawler from the purely navigational point of view—and these craft may spend many days at sea in continuously thick weather—the echo-sounder has proved of inestimable value in finding the banks where the skipper knows that the fishing is good. In many cases these banks are surrounded by depths of 100 fathoms with deeper water at no great distance, and though the skipper may use a sextant to find his position, the shallow spots have to be felt for, and this can now be done without stopping the vessel to heave the lead. It is largely for these vessels that the Mark 3 and 4 Shallow Water apparatus were designed, for with them soundings up to 250 or 500 fathoms respectively can be obtained.

In conclusion, I will add that approximately 60 per cent. of the soundings taken by H.M. Surveying Ships are now taken by echo, and from this information the Admiralty charts are produced and kept up to date. Its reliability has been amply proved by the gruelling of continuous running in those ships; and to the opinion of their captains that any man of ordinary hearing and intelligence can work the instrument may be added the similar testimony of a trawler skipper, any one of whose crew was able to obtain a sounding by the end of their first cruise as shipmates with the gear.

Finally, I must thank Lieut.-Commander Day, R.N., of the Hydrographic Department, and Mr. D. J. Matthews and Mr. J. Buckingham, of the Scientific Research and Experimental Department of the Admiralty, for the help they have given me in preparing this paper.

DISCUSSION

Before the paper the PRESIDENT (Col. Sir CHARLES CLOSE) said: This afternoon we are going to hear an account by Admiral Douglas, Hydrographer of the Navy, of the relatively new method of determining the depths of the sea by echo sounding. It is one of those methods obvious in principle but difficult to work out in practice. In that respect it is somewhat like sound-ranging. We hope to learn from Admiral Douglas the method by which echo-sounding is carried out, and I will ask him now to begin his lecture.

Admiral Douglas then read the paper printed above, and a discussion followed.

Mr. MATTHEWS (Department of Scientific Research and Experiment, Admiralty): I think we may say that we know the vertical velocity of sound in the sea to 1 : 300, corresponding to a change of 1° C. in the average temperature of the water. From 500 fathoms downwards it is probably known with greater accuracy than this in regions where observations of temperature and salinity have been made. In shallower water there is a seasonal variation of the temperature down to 200, 300, or even 500 fathoms, and if one uses the average temperature for the year one is apt to get small errors. In the English Channel or North Sea the error per cent. might be rather large, but the actual error in fathoms is small. Midway between Lands End and Ushant, for instance, there might be an error of half a fathom in a depth of 60 fathoms. The greatest difficulty is in calculating the tables. They were calculated on purely theoretical grounds from determinations of the density and compressibility of water made in the laboratory. All the determinations of the compressibility of sea-water have been made by V. W. Ekman, the Swedish physicist, who used as his pressure gauge the compressibility of pure water which had been determined some forty years previously by Amagat, the French physicist. Ekman said that his tables were accurate to about 1 per cent., but there is no doubt, from the close agreement between theory and practice we have in the English Channel and the Straits of Dover, that his figures are far more accurate than that. I should say to 1 : 500 instead of to 1 : 100 is more likely.

There is one rather interesting correction which has been made in the Admiralty Tables, and that is for the adiabatic velocity. Sound goes through the water as a wave of compression, and when water is compressed it is heated, and therefore the sound-wave is travelling in water that is hotter than the surroundings. It is always heating its path, and it passes so quickly that the excess temperature has no time to leak away. One can calculate what the rise is if one knows the specific heat and compressibility and other properties of water, and the Admiralty Tables have been calculated with that correction included. The American Naval Tables have put the correction in separately because they were not certain whether it ought to be applied; I suppose because they were not certain whether the excess temperature would leak away sufficiently fast. However, there seems to be no doubt that the Americans have agreed since then that the correction should be applied. The tables of some countries have omitted it, and I think the resulting error has been very great. When you get to depths of 5000 fathoms and more, such as are found near the Philippines, you may get errors of hundreds of fathoms through neglecting the heating of the water by the passing of the sound-wave.

Mr. H. A. HUGHES: I should like to express regret that my brother, who has superintended the fitting of the echo-sounders on ships, is unable to be present. I think the most interesting contribution I can make is the fact that it has been found that each ship is more or less a problem in itself. There have been about 120 ships fitted now, and in each case my brother has had to investigate the problem, sometimes in consultation with the Admiralty. It has been most interesting to note the way in which the various difficulties that have arisen have been overcome in each case. All the ships have been successfully fitted. The enthusiastic support of the navigating officers has been a great help in that respect, for they have taken up echo-sounding with the utmost keenness. The old system of sounding is very troublesome, and of course with trawlers it is a danger to life in heavy weather. My brother has during the last week or so been in the Bay of Biscay with the Dutch Survey vessel. Then he went across to the

M.V. *Augustus* at Genoa, and now he is on the Canadian National Line ship that has just sailed. It is necessary to go to each ship and investigate the problem; in fact, as a result it has been found that a great deal can be done in the method of fitting the transmitter and the hydrophone. In the *Viceroy of India* an air chamber has been provided, part of the tank having been separated off. Undoubtedly there is a screening of sound by that means. In the case of earlier ships the two gears have been fitted in the ship's tanks, each gear being in its own little tank, but the air-space has not been divided off. If that is done clearer results are obtained. No special operator is employed; any navigating officer who wants to know what the depth is at once goes to the machine and ascertains it.

As I said, difficulties that have arisen have been met, and there is no doubt that now there will be great development in the use of the gear, especially in thick weather, and it will be of very great assistance in navigating a ship.

Dr. S. W. KEMP: I have listened with the greatest pleasure to what Admiral Douglas has told us about these gears, the principles involved, and the different ways in which they are applied. In the course of the plankton and hydrological survey which we are making of the whaling grounds of South Georgia it is very important that we should have an accurate knowledge of the contour of the sea-bottom. The bottom in that particular area is exceedingly uneven: it appears to have deep gullies and is mostly rocky. The weather, moreover, is often very thick, and it is extremely difficult to get good and accurately fixed soundings. The depths extend to at least 1000 fathoms, and the machine in which I am particularly interested is the deep-water pattern which would have sufficient range to help us out in that area. With an efficient deep-water machine and lines run in fair weather, I feel sure that in the course of a few weeks we should be able to clear up the contours in the neighbourhood of South Georgia as beautifully as Admiral Douglas has shown us in the case of the Challenger Bank.

Sir HENRY LYONS: I should like to ask the Hydrographer if there has yet been a sufficient number of deep ocean soundings to give any idea of the order of the corrections we are likely to expect when large areas have to be sounded over. I take it that the deep ocean soundings will come out at less than the old line-sounding.

Lieut.-Commander GOULD: There is one point to which I should like to draw the attention of the Society on this occasion. It is not directly concerned with echo-sounding, but it relates to a method which is so much allied to this that it is worth noting: namely, the method, devised by Dr. C. W. Siemens in 1876, of obtaining soundings without the use of a sounding line.* To this end Dr. Siemens devised a mechanism, which he called a "bathometer," which could measure very slight variations in the total attraction of the Earth, and could therefore be used to determine the actual depth of water under a ship. An early form of the instrument was tested on board H.M.S. *Firebrand* in 1859, and an improved model in H.M. Surveying Ship *Fawn* in 1876. I have conversed with an officer of the *Fawn*, who told me that the results obtained were accurate up to 250 fathoms, after which the instrument was apt to give irregular results, owing to mechanical defects. It was a very simple piece of mechanism and hung in the captain's cabin, giving continuous readings to single fathoms. I suggest that it might possibly be worth the Society's while to direct attention to the revival of such a machine at the present day, because, as far as I can gather, it was most simple and could be far better made now than then. Moreover, it might be used not only in ordinary navigation but also in isostatic investiga-

Philosophical Transactions of the Royal Society, 1876, pp. 671–692

tions. It is certainly far less complicated than Dr. Meinesz' apparatus, with its three pendulums and all its ancillary mechanisms.

Sir GERALD LENOX-CONYNGHAM: With reference to the bathometer, I was not aware that a successful instrument for detecting such small changes in gravity as that implies had ever been devised. I should be very curious to know what the principle was, but I will look it up in the *Philosophical Transactions*.

Lieut.-Commander GOULD: It was used to determine the height of the Clock Tower at Westminster.

Lieut.-Commander L. C. BERNACCHI: Is there anything in the nature of horizontal reflection of sound from the steep slopes of the Challenger Bank, and, if so, was it troublesome or confusing so far as the use of the apparatus was concerned?

The PRESIDENT: I should like to ask a few simple questions. How many readings are taken? Are you content with one reading?

Admiral DOUGLAS: Yes. We generally have two telephones fitted, and the operators are checked occasionally by an officer. In our ships we have a man known as a recorder who is a seaman, and he takes the readings.

The PRESIDENT: You do not read the same depth more than once?

Admiral DOUGLAS: Not in practice.

The PRESIDENT: At great depth is there any difficulty due to loss of sound?

Admiral DOUGLAS: There is generally no difficulty in getting the echo off the bottom however great the depth of water. It depends, of course, on the strength of transmission; the hammer used in the deep-sea apparatus is a pneumatic one, and the only loss of echo one would get would not be so much from the depth of water as from the nature of the bottom.

In that connection it may interest you to know that in our work on ships sounding with the shallow-water apparatus round the coast of England and Scotland it is quite easy for the operator listening to tell at once practically what the nature of the bottom is. Although I said in my lecture that the echo does not return with a sample of the bottom, you can tell from the type of echo what the bottom is. If it is rocky you get a sharp, crisp echo; if mud, a dull echo; if sand and shell, an echo intermediate between the two. A skilled operator can thus judge at once what type of bottom it is. An operator does not listen for much more than twenty minutes a day when sounding continuously.

Sir Henry Lyons raised the question of deep-sea soundings. Well, I am afraid we do not know very much about that at present. The German Research Ship *Meteor* returned about a year and a half ago with an enormous number of soundings; in fact, she took more in the Southern Atlantic Ocean than were ever taken before by all the ships that previously took soundings in this area. Those responsible are still busily employed correcting those soundings for the proper velocities of sound, and they have raised the interesting point whether the echo in these great depths is reflected back from right under the ship. It is obvious if you have an echo going out in shallow water and you are passing really close to a sandbank which is nearer to the ship than the bottom beneath her you get an echo off that sandbank before you get the echo from the bottom under the ship, because the instrument is not directional to that extent. Similarly in deep water you may get soundings from depths considerably less than the truth if the bottom slopes much. That is a problem we have to tackle, and we are going to look into it as well as we can directly we have our ships fitted with the deep-sea apparatus.

The only other point which may be of interest is that Mr. Hughes did not mention that the shallow-water apparatus is so easy to read that some ships have had loud speakers fitted to them. They hear the echo through the loud

speaker instead of through telephones. Mr. Hughes told me this afternoon that the Admiralty have just passed a design for the self-recording mechanism of the apparatus, from which, I take it, one will be able to record depth on a drum on the Barograph principle.

The PRESIDENT: One more question. When used by unskilled operators such as fishermen, are any corrections necessary at all? Can they read straight off?

Admiral DOUGLAS: You can read straight off the machine; there is a small correction, but, as Mr. Matthews pointed out, it is negligible.

The PRESIDENT: Are there other corrections in addition to those for temperature?

Admiral DOUGLAS: There are small corrections for pressure and salinity, which are negligible in depths such as those of the North Sea, where they are obtaining soundings up to 200 fathoms. There is a small cam which allows for the distance between the transmitter and receiver. This is adjusted once for all when the apparatus is installed. In addition to this there is a small scale on the depth pointer which can be adjusted so as to allow for changes in the draught of the ship. This can of course be also adjusted so that the depth read off is either the total depth of the water from surface to bottom or the depth of water under the ship's keel. The depths obtained with the echo gear are more accurate than those obtained with the lead line, and in addition there is not the difficulty of reading the point where the line meets the surface of the water which may be disturbed by waves.

The PRESIDENT: I am sure you will wish me to thank Admiral Douglas for introducing a subject which is of great importance. It is delightful to see a bit of apparatus which began by being, shall I say, a sort of scientific toy ending as something which every ship will probably eventually use. In your name I beg to thank Admiral Douglas for his lecture.

Note on the Bathometer

Sir GERALD LENOX-CONYNGHAM, F.R.S.: The mention of the bathometer by Lieut.-Commander Gould at the meeting of March 11 raises the question whether, if one had a trustworthy static gravity-meter, capable of being used on board ship, one would be able to deduce from its indications the depth of the water under the ship, or, to make the problem somewhat less formidable, the change in depth as the ship moved from one place to another.

A 50-feet increase in the depth of the water under the ship, that is to say, the substitution of 50 feet of water for 50 feet of rock, produces a change in the force of gravity of 0·001 cm./sec.^{2}, which is approximately one-millionth of g. To measure anything correctly to one in a million is difficult, and it is clear therefore that the gravity-meter must be capable of great precision if gross errors in the deduced depth are to be avoided. It is to be noted that the effect on g just mentioned is the maximum effect. If the horizontal extent of the deeper area were small, if, for instance, it could be represented by a circular disc of which the radius was less than ten times the depth of its upper surface, then the effect would be somewhat less. If, therefore, a ship moved from 5 fathoms of water to 14 fathoms the effect would scarcely be measurable. In deep water, however, where changes so small as 50 feet would have lost their importance, so high a degree of precision would not be requisite. But here we are met by the difficulty that the value of g does not depend on the depth alone. It depends also on the latitude and the distribution of mass in the Earth's crust. The law of its variation with the latitude is well known, and may be readily taken account of, but the effects of irregularities of mass are much more difficult. In his voyage to Java via the Mediterranean, Red Sea, and Indian Ocean, Vening Meinesz, knowing

the depth at the places where he made his gravity determinations and making the best assumptions that he could with regard to the distribution of mass, found the following anomalies, that is to say, differences between the results of observation and the values calculated from the known latitude and depth and the assumed distribution of mass:

Station.	*Anomaly.*	*Station.*	*Anomaly.*	*Station.*	*Anomaly.*
1	0·027	11	0·040	21	0·007
2	0·023	12	0·090	22	0·042
3	0·130	13	0·065	23	0·078
4	0·074	14	0·086	24	0·044
5	0·042	15	0·057	25	0·034
6	0·033	16	0·056	26	0·001
7	0·035	17	0·043	27	0·001
8	0·008	18	0·014	28	0·005
9	0·004	19	0·021	29	0·037
10	0·005	20	0·005	30	0·036

The average of these numbers is 0·038, and it is clear therefore that if the depths had been computed from the observed values of g the average error would have amounted to 50×38, or 1900 feet, and in the extreme case to 50×130, or 6500 feet. It seems, then, that the views held in 1876 by the inventor of the Bathometer as to the possibility of deducing the depth of the ocean from the value of gravity at the surface have been shown by more modern experience to be incorrect. Nevertheless, if the instrument had proved itself capable of measuring changes in the value of g its value would have been but little affected by the fact that it could not be used for determining depths. When, however, we turn to the inventer's account of the performance of the apparatus we meet with discouragement. In one place he says that "the correction for latitude (for some reason which I am unable to explain) is much less in this instrument than it would be in the case of pendulum indications," and farther on that "the differences of latitude do not seem to exercise the full amount of effect upon the instrument which might be expected." We cannot but conclude that there were undetected sources of error which masked the effects of which the observer was in search.

The idea of the instrument is that which the work of Hecker and Duffield has made familiar, namely, that of balancing the weight of a column of mercury, which depends on g, against a pressure, which is independent of g. Mr. Siemens used spiral springs to produce the balancing pressure, and it was doubtless some inconstancy in their action that made the indications of the instrument untrustworthy.

THE OXFORD UNIVERSITY EXPEDITION TO GREENLAND, 1928

T. G. LONGSTAFF, M.D.

THE Oxford University Expedition to Greenland in 1928 was undertaken to continue the biological work of the three previous Oxford expeditions to Spitsbergen, the ecology of which region has now been fairly well worked out.* Our object was not geographical in the ordinary sense of the word, nor the mere collection of specimens. Ecology is the study of the inter-relations of all the forms of life, both floral and faunal, inhabiting a given area. It is rather the Cinderella of the biological sciences, which have concentrated more on the study of the form of individual species than on the particular niche each one occupies in that complex web of life of which we consider ourselves to be the centre. The work of the systematist in the museum or the laboratory yields comfortingly definite results: the ecologist—the field naturalist—working amongst an indefinite number of unknown factors, can seldom congratulate himself on finishing anything.

In the tropics the numbers both of species and of individuals is so enormous that, in the present state of our knowledge, ecological research is almost hopeless. Conversely, the high Arctic gives us a far more favourable field. Our idea was to try and link up the life conditions which have been investigated in Spitsbergen with the far more complicated problems of the British Isles. The latter still exhibit the biological effects of the last glacial maximum which, according to modern Scandinavian geologists, was still active less than ten thousand years ago, pushing the " cold front " and the storm belt far to the south of their present positions, thereby profoundly altering the distribution of life forms. A connecting link, representing a previous phase from which our present British conditions have developed, should be found in Greenland, nearly 90 per cent. of which is still covered with ice. But we must go north of the last silver birches, which are found on the south-west coast up to 62° N., to find something comparable with the same biological phase of development that our islands were in at the close of the last glacial maximum. Climate is obviously the decisive factor in the distribution of life, and by going 40 miles in from the outer coast we should escape the cold fogs and rain of the maritime régime and still be well away from any too rigorous continental effects or any interference from the near presence of the inland ice. We also had to secure an area completely free from human interference, that is, well away from any Greenland settlement. We are mu indebted to the Danish authorities for giving orders to the Greenlanders not to visit our working ground before or during our stay.

More particularly we had to find a territory rich in land-bird life, for the breeding of these summer migrants is such an outstanding problem of the bionomics of northern lands. The coastal region is exceedingly mountainous, and to find a numerous land-bird population it was obviously necessary to seek low ground, well back from the outer coast-line. Such an area was indicated on the Admiralty Chart at the head of Kugssuk, the north-west arm

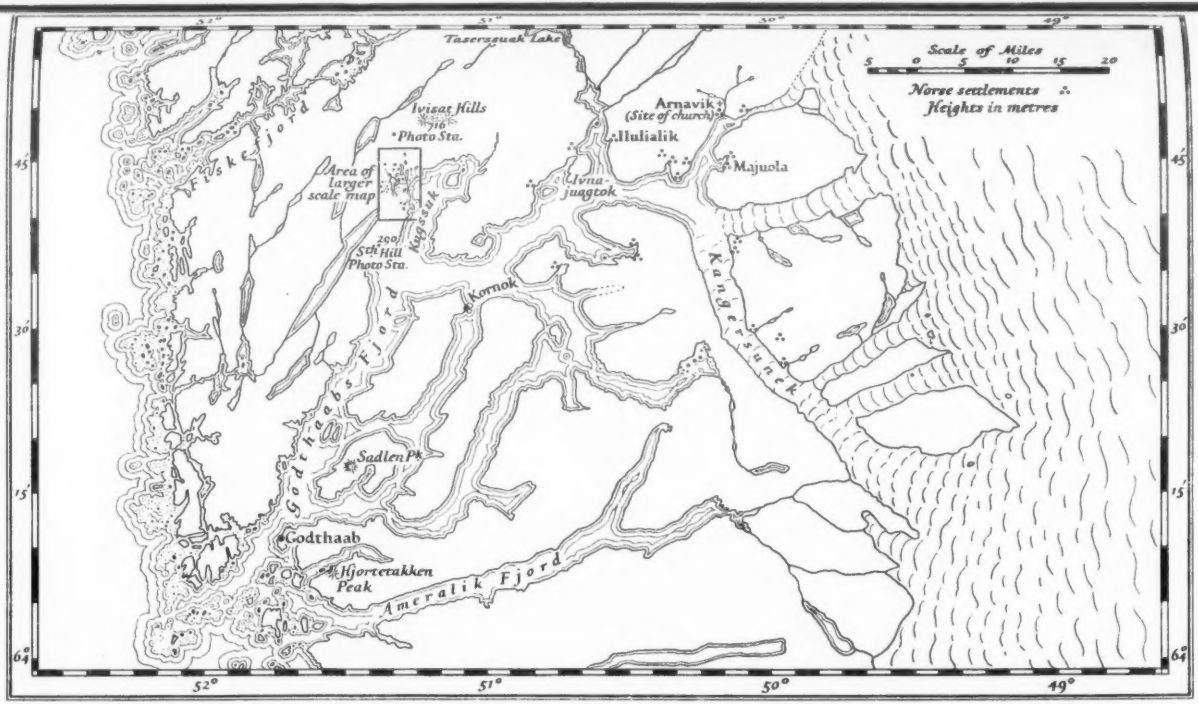
Vide " Further Contributions to the Ecology of Spitsbergen," by V. S. Summerhayes and C. S. Elton, the *The Journal of Ecology*, vol. 16, No. 2, August 1928.

of Godthaabs Fjord, where a number of small lakes are shown scattered over an area south of the Ivisat Hills. Here, at a camping-place known as Isersiutilik, the expedition landed on 16 June 1928, and camped for six weeks, investigating a limited area of about 8 square miles. It is interesting and illuminating to note that during our stay the temperature never fell to freezing-point, and that we only lost about seven days' work through bad weather. The abundance of water-plants, which are completely absent from Spitsbergen, indicates a relatively mild winter climate.

C. G. Trapnell, the original organizer of the expedition for the O. U. Exploration Club, came as a botanist, assisted by Sir John Hanham, who was also our interpreter. Max Nicholson was our ornithologist, assisted by his brother, B. D. Nicholson, who also acted as assistant topographer. W. G. H. D. Crouch was photographer, quartermaster, and cook. Major R. W. G. Hingston, M.C., second in command, was our entomologist and director of the scientific work. H. P. Hanham was my universal assistant. To the two Hanhams our party is indebted for almost all the fish and fowl which constituted the whole of our fresh meat supplies during the trip—especially for about 400 lbs. of "salmon" obtained by them in various ingenious ways. As taxidermists we had the services of Julius Olson, relieved later by John Møller, both very charming Greenlanders. I think it is worth recording that the whole expedition cost under £500, more than half of which was passage money to and from Greenland and Copenhagen.

Isersiutilik, about 64° 40′ N. and 51° 40′ W., is an occasional hunting-camp site, lying on the north-western shore of the Kugssuk branch of the main Godthaab Fjord, the Rangafirth of the old Norsemen. The country is craggy moorland, interspersed with lakes, large and small, which occupy nearly one quarter of the 8 square miles we had selected as our laboratory. It has the appearance of a sunken rather than of a denuded series of very shallow valleys, mostly lake-filled, and running generally from north-east to south-west, amongst which rather isolated granite hills rise to 450 feet above sea-level. Many of these hills are simply littered with boulders left stranded by the recession of continental ice.

To the north of this sunken area the Ivisat hills rise to about 2500 feet, while to the south is another group of bold but slightly lower summits. West of each of these small ranges is a complicated system of grand lakes, and these two systems are united, along the eastern foot of the Fiskefjord ranges, by a series of smaller lakes flowing one into the other by rocky channels, in one of which the Nicholsons discovered a waterfall. As a rule the drainage is poorly developed and there are no genuine rivers; but the soil is so shallow over the underlying rock that there are also no large swamps or bogs, though small ones are numerous, so that the type is probably closer to the Barren Grounds of Canada than to the Tundra of Siberia. The shore-line appears to me to be sinking at the present time, a phenomenon for which there is good evidence in the submergence of ancient Norse remains in other portions of the south-west coast. On various excursions we saw enough to realize that this great coastal strip of ice-free land between Godthaab and Sukkertoppen, which is some 80 miles in breadth from the outer sea to the Inland Ice, offers a good field for topographical exploration, combined with the interest of the solution



Godthaabs fjord and the Inland Ice: Western Greenland

Note: the lakes north and west of the area enclosed by lines are from the Danish Admiralty Chart "Vestkysten af Grönland," dated 1887. They are said to be from native information only and unreliable.

of most difficult problems in transport and supply. I believe that something could be done with canoes or very light dories, using the chains of lakes, but my friend Helge Bangsted considers that Iceland ponies would be the better solution.

So far no actual surveys have been made in West Greenland, and the available maps are merely sketches. We made a plane-table sketch of our territory on a scale of $3\frac{1}{2}$ inches to the mile, for the use of our biologists, but I had no time to include the remarkable lake systems to the north-west and south of our field of work.

It is unprofitable to try and discuss our scientific results until our various collections have been worked out in detail, so I will only attempt the briefest outline of our work. There are no reptiles at all in Greenland and it is too close to a " glacial epoch" to harbour any voles, mice or rats. We had the Arctic hare and the Arctic fox with us. The reindeer was up in the higher hills at this season. The musk ox, the wolf and the lemming have not yet been able to invade the south-west coast from North Greenland across the great glaciers of Melville Bay, though all three have penetrated far round the desolate Northland to the east coast. The Polar bear is not a land animal but a creature of the ice-pack, and is but rarely seen even in winter on this coast. Seals also were scarce and unprocurable in the inner fjord at this time of year.

One of our chief tasks was the bird census, undertaken by the Nicholsons with occasional help from other members of the party. As a result of hard work, 727 pairs of birds, of fourteen species, were located and their distribution mapped. This gives a lower concentration than on English farm-lands, but a higher one than on the New Forest moors, and in my opinion higher than on western Scottish moors. Observation indicated that competition between individuals was less keen than in Britain, and that there could not be any serious struggle for existence between them in summer-time owing to the abundance of plant and insect food. There were on our ground 321 pairs of Lapland Buntings, 149 of Redpolls, 84 of Snow Buntings and 61 of Wheatears. Now the majority of these birds are summer migrants, coming north only for the breeding season. Why do they come ? It is futile to answer "instinct" when we know that only a few thousand years ago they could not have bred here, owing to the effects of the last glacial maximum, which must have produced conditions similar to those of Spitsbergen at the present day, where of the above birds only the Snow Bunting occurs. We must go to the entomologist and the botanist for an answer. Hanham and I collected, from outside our census area, over 100 birds, and from the stomach contents of these, now being worked out by O. W. Richards, we hope to obtain some accurate data. For the specific names of his insects Richards is, of course, dependent on the specialists, who are still investigating Hingston's collections, but meanwhile he draws attention to two interesting points: a certain weevil was much commoner in the stomachs than in the collection, so as regards numbers the stomach contents are a useful check on collecting in the field; but if, as seems probable, *no* insect which Hingston did not collect is found in the stomachs it will be a great feather in Hingston's cap. Richards also notes that the relatively large number of parasitic hymenopterous flies in the stomachs

Looking south-east to Isersiutilik over expedition's working ground: coast range above Godthaab in distance

Silt polygons at head of Kugssuk: willow scrub and fluvial terraces in background

indicates that the birds are feeding on the enemies of the insects as well as on the insects themselves, so that it will be very difficult to gauge the effect of the birds on any particular insect. All our skins have been presented to the Natural History Museum.

Hingston reports that "the most striking feature in the insect life was the immense number of individuals compared with the fewness of the species. Every square foot of ground might be said to harbour flies of some kind. At times the air was filled with mosquitoes. So numerous were the insects that nesting birds could sometimes get sufficient food within a few feet of their nests. Yet in spite of these numbers of individuals only about 131 forms of insects and Arachnids rewarded a six weeks' search. By far the largest group was the Diptera (two-winged flies). Forty-two species were collected. Hymenoptera (bees and wasps) come next with 15 species; then Coleoptera (beetles) with 13 species; the Lepidoptera (butterflies and moths) with 12 species. The remaining orders were much less numerous. Certain groups were noticeably unrepresented. For example, no grasshopper, locust, cricket, earwig, dragon-fly, ant, or springtail was found anywhere in our area of work. Another feature was the number of spiders and mites which, both at high altitudes and high latitudes, augment the insect fauna. All the collections are at present in the hands of specialists, and, until they have been critically examined, it is not possible to go further into detail." All our material goes to Professor E. B. Poulton, F.R.S., for the Hope Department at Oxford, where the Spitsbergen collections are also deposited.

Trapnell reports that "the vegetation about Isersiutilik varied remarkably, even every few yards, although the principal constituents of the flora were fairly constant. The ground had the appearance of a patchwork quilt of lichens, especially *Cladonia alpestris*, growing with mosses in dense mats among patches of dwarf shrubs. Of these, Crowberry (*Empetrum nigrum*) is the most universally distributed, and provides a link with the inner fjord vegetation of Spitsbergen. Dwarf Birch (*Betula nana*) is plentiful and the Azalia-like *Ledum groenlandicum* often accompanies it. A bilberry (*Vaccinium uliginosum*) is common, and a small form of it fruits abundantly on the stony ridges, where *Dryas integrifolia* is found, and, less frequently, *Rhododendron lapponicus*. In the deeper soil of hollows or valleys the Grey Willow (*Salix glauca*) forms copses a yard high. The flora appeared to comprise nearly 150 flowering plants and ferns, besides the many lichens and mosses, among which a new species has been determined." It may be noted that of the whole Greenland flora, estimated by Ostenfeld at 390 higher plants, some 200 species are circumpolar, while 53 have been found also in North America but not in Europe, and 32 in Europe but not in America, a few of the latter being attributed to the early Norse settlers. Ostenfeld believes in the survival of the hardiest polar species throughout the last glacial maximum. Trapnell's large collection goes to Kew.

On July 2 some of us made a boat excursion up to the head of the Kugssuk arm of the fjord, which we found very shallow, with an abominably soft mud bottom, on which grass-wrack (*Zostera marina*) was growing, providing a popular feeding ground for many mallard, ice-duck, and merganser. The chart shows a largish river some 15 miles in length flowing southward down

Silt polygons at head of Kugssuk: willow scrub and fluvial terraces in background

the wide, level valley between the Ivisat hills and the range backing on Ivnajuagtok; but we only found a muddy streamlet in the time at our disposal. There were at least two well-marked systems of fluvial terraces in this valley. The soil is a very fine silt, typically glacial in appearance, but with few boulders, and this was the only locality where we saw really well-developed polygons covering large areas. On this soil crowberry was less and bilberry was more luxuriant, and prevalent, than at our base camp at Isersiutilik. The Lapland Bunting, which I cannot help associating with crowberry, was far less common. Both willow (*S. glauca*) and alder (*Alnus crispa*) were markedly more luxuriant and covered larger continuous areas than at Isersiutilik, and the Redpoll was correspondingly commoner. Generally, owing to the greater uniformity of the soil and to more favourable climatic conditions, vegetation appeared far more consistent and of stronger growth than around Isersiutilik, larger areas being dominated by the same type of vegetation than in our patch-work working area, and in consequence the bird population was less mixed and less numerous. But while for our particular purposes this locality was not so good a laboratory as Isersiutilik, yet I believe it would be more interesting to the physical geographer and would well repay investigation. Hard walkers with suitable outfit should be able to reach the great Taserssuak lake to the north by proceeding up this valley. Either Taserssuak once discharged silt from the Inland Ice down this valley, or else there must have been large glaciers, or even continental ice, at its head. Unfortunately shoal water prevents access by boat to the head of the bay, and consequently makes the selection of a good base camp site a matter of difficulty. On our return we were caught by a westerly blow, and had to take refuge on an island, reaching camp at 2 a.m. next day.

The kindly loan of a motor launch by the Governor enabled a party to approach that area at the head of the Godthaabs Fjord system, the old Rangafjörthr ("Crooked Firth"), on the shores of which the "Western" Norse settlements were made in the eleventh century. Landing on the shore at Ilulialik opposite the great bird-cliffs of Ivnajuagtok (meaning "people wonder why it doesn't fall down"), Harry Hanham and I spent a delightful day on the hills above our camp, about 2300 feet, "zoning" the birds and plants according to altitude, while Hingston collected insects. From the tops there are glorious views over the confused snowless inner hills, about 20 miles in depth, beyond which rise the mysterious undulations of the Inland Ice. All this country looks very wild and fascinating and offers an intriguing field for exploration on a small scale. To the north, between 70 and 80 miles away, shone the high snow-peaks of Sukkertoppen, and in the middle distance gleamed the foam of the great waterfall from Taserssuak Lake, so difficult of access owing to the silting up of the head of the fjord by glacial mud. Westward are strung out the steep snow-clad peaks of the outer islands which constitute the coast range, separated by fjords of infinite variety. Southward we looked up the Kangersunek firth, the site of many an old Norse farmstead; but access to these is now blocked by heavy ice calved from continental glaciers, which must have advanced during historic times—and for all we know retreated and again advanced several times.

Around Ilulialik we found the flora of the sheltered glens more luxuriant

Plane-table sketch of working area at Isersiutilik

than in Kugssuk, a number of plants ascending to higher altitudes, the alder (*Alnus crispa*) more plentiful and, with the willow, growing often to 6 feet in height; but it was a case of richer growth rather than additional species that was noticeable. Trapnell considered that the abundance of the white heath (*Cassiope tetragona*) on the hills above Ilulialik was a sure indication of clearer weather conditions than at Kugssuk. I believe that Ilulialik represents the zone of local climatic optimum at the present time. As we went farther in towards the continental ice at Majuola I thought I detected signs of a more rigorous climatic régime and of outward-blowing easterly winds. Certainly plant growth was less luxuriant and birds less numerous, while Hingston reported quite a different composition in the insect population. Surely the zone of the climatic optimum has shifted a few miles seaward since the eleventh-century Norsemen settled here? Ilulialik and Majuola are the first old farm sites we reach, but the main centre of population was farther up, along the Kangersunek arm. Even in July we found it impossible to reach these settlements (where horses, sheep and possibly cattle are supposed to have been kept), owing to the masses of ice calved from the glaciers flowing into the sea from the inland ice, which formed an impassable barrier to the whole Kangersunek arm. We could not even visit the site of Arnavik Church, which is only a little way in beyond Majuola. It was perfectly obvious that no settlers could get there, much less live there, under present conditions and that some deterioration of climate must have taken place since those times. Dr. Nörlund* has shown grounds for believing that such a change set in between 1300 and 1350, by which latter date Eskimo coming down from the north, driven south, I doubt not, by the same factor, had destroyed these "Western" colonies, as local traditions tell to this day. Recent excavation at Herjolfnes, in the extreme south of Greenland, makes it appear that the last Greenland Norseman died about 1540; and the diseased condition of the bones indicate that here, in the "Eastern" colonies, extinction was more probably due to deteriorating conditions of life than to Eskimo invasion. It should be remembered that it was only in the middle of the fourteenth century that the Icelanders gave up the attempt to grow their own bread corn. In 1492 Papal correspondence states that no ship had visited Greenland for eighty years, in consequence of difficulties due to ice, which is never referred to in the early records. The Runik inscription of 1135 found on Kingigtorsuk (72° 55′ N.) is dated end of April or early May.† If ice conditions in Baffin Bay were anything like what they are now, the party must have wintered there. But from the inscription "raised their marks and cleared ground," *i.e.* "took possession of," it seems to me likely that Sigvatson and his companions must have sailed there in April—an incredible feat nowadays. We have therefore evidence of a change of climate in quite recent times, small in degree but considerable in effect, which may make us the more ready to accept the views of de Geer's school on the date of the last "Ice Age" and the theories of climatic cycles put forward by Brooks. It is to be observed also that prehistorians are almost daily publishing more evidence to the same effect.

**Meddelelser om Grønland*, 1924, vol. 67, p. 228.
†Laing's 'Heimskringla' (London, 1844), vol 1, p. 153.

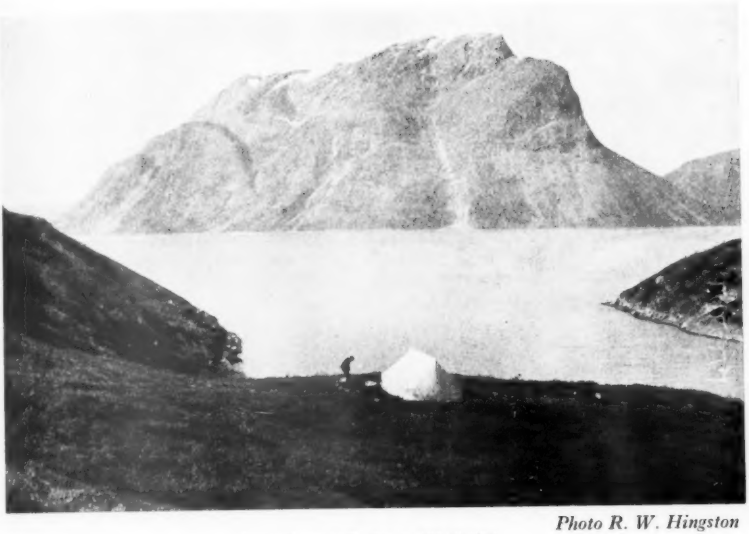


Photo R. W. Hingston

Ivnajuagtok from Ilulialik

Looking south to Isersiutilik from Hammer Cliff Cairn over Hammer Tarn and Long Tarn

Vegetation at 500 ft. on Ihulialik hill

Happily for its inhabitants, Greenland is a "closed" country, and long may it remain so. But properly accredited scientific workers are welcomed, and so soon as the University, through the benevolence of the Vice-Chancellor, Dr. F. W. Pember, officially backed the expedition, the Danes sanctioned our plans and did everything possible to aid us. We have more particularly to thank Mr. Daugaard-Jensen of the Greenland Administration in Copenhagen; Mr. K. Honoré Petersen, Governor of South Greenland; and Mr. C. Simony, Governor of the Godthaab district. The ready advice of our Gold Medallist, Dr. Lauge Koch, was also invaluable to us during the formulation of our plans; and we shall ever remember the kindness shown us by Captain O. Petersen of the *Gertrud Rask*, and by Captain N. Bregnhof of the *Hans Egede*. Every Greenlander we met was helpful: their honesty is positively shocking to visitors from more enlightened lands; their happiness is a queer comment on our ideas of "progress" and a striking testimony to the unique foresight of the Danish system.

THE OCEANOGRAPHICAL CONGRESS AT SEVILLE

THE International Congress of Oceanography, Marine Hydrography, and Continental Hydrology—to give it its full title—was organized by the Spanish Government to give point to the exhibition of instruments pertaining to these sciences, that made a kind of prelude to the great Ibero-American Exhibition so long in preparation in Seville. The Congress had the enormous advantage of a superb building, the Palacio de la Plaza de España, built in the pale pink brick for which Spain is famous, and which its builders use so admirably; adorned with marble columns and tiles in the Moorish manner, set in a park well grown and gardens some years planted, so that it had none of the improvisation associated with exhibition buildings: a permanent building that will adorn the city long after the transient features of the show are gone. Its intention is to provide a lodging that will bring congresses to Seville; and indeed they would find it hard to discover more agreeable quarters, even though in truth the conference halls are bad acoustically; they provide excuse for withdrawing to informal discussions in the wholly admirable patio.

The Congress was opened on May 1 at a solemn session under the presidency of the Infanta Don Carlos, Captain-General of Andalusia, and thenceforward divided its labours into two sections—of Oceanography and of Continental Hydrology. The delegate of the Society, being extemporized into a Vice-President of the former, had little opportunity of attending the deliberations of the latter, which soon came to an end: but the Oceanographical section ran to the full length of the Congress, and though true to type in that many of the communications had little international significance, it gave welcome opportunity for renewing old acquaintances and making new, and it raised very appropriately the question of what shall be done to provide for the Ocean an equivalent to the *Carte du Monde au Millionième*. In a summary of

the present position M. Courtier pointed out that of the 2642 sheets in the index to the 1/M map, no less than 1786 belonged entirely to the sea, and there was little probability that more than a very few of these sheets would ever be published by the organizations responsible for the sheets of the nearest adjacent lands. At present the only general bathymetric chart of the oceans is that of the Prince of Monaco on Mercator's projection, of equatorial scale 1/10M. It is very much out of date; a new edition is in contemplation; but, as was remarked in private by a man largely responsible for the first, there is very little encouragement to bring out a new edition when so large a part of the first remains unsold.

The invention of echo-sounding has complicated the problem, by providing minute detail on a few routes or in a few places, out of all proportion to the detail which can be obtained in any reasonable time or at any possible expense for the ocean at large. To aim at publishing 1786 sheets on the scale of 1/M is out of the question, but one may envisage a general chart of the ocean on 1/5M or 1/4M, though even for those small scales the material will be very deficient for many years. Since there is especial interest nowadays in polar oceanography it is desirable to provide for a better transition from sheet to sheet than that given by the awkward junction of the polar quadrants with the Mercator charts of the Prince of Monaco's map, and the choice of projection demands serious study. For the heavy task of compilation and publication the German delegates demanded the creation of a new international organization, but others deprecated a hasty resolution to this effect which would have certainly remained as sterile as the many unofficial resolutions in favour of the 1/M map. So the subject was held over for consideration during the week-end, and a long Sunday excursion to Jerez de la Frontera gave opportunity for inspiration and informal conversation, leading to the safe and possibly fruitful decision on the Monday to invite the International Hydrographic Bureau at Monaco to study the subject.

One does not remember that any other subject of real international significance was fully discussed; but a resolution in favour of Professor Pettersson's scheme for prompt publication of certain charts of surface temperature for the North Atlantic was put rather suddenly and passed without dissent, though with some abstentions from voting. It seemed to deal with a matter of administrative action which had already been decided by the International Council for the Exploration of the Sea, the body immediately concerned, and the British delegates were not prepared to vote for what had the appearance of questioning an executive decision already taken by the competent authority. Later information seemed to show that this was not a complete view of the case, and that we need not have refused support to Professor Pettersson. Happily it made no difference. But the case illustrates the importance of a principle that is often neglected in such conferences, that the discussion of resolutions designed for transmission to governing bodies should be introduced as early as possible, and that the vote should be deferred as late as possible.

It is impossible to summarize briefly the individual communications made to the section: we must await the publication of the Congress report. To many it will seem that the most valuable feature of the meeting was the

opportunity it gave to discuss new apparatus shown in the exhibition with the inventors and constructors of it. It was, for example, a particular pleasure to meet M. Florisson, who has been responsible for the development of the Langevin supersonic sounding apparatus, and to study the machine under his guidance. In a recent discussion on echo-sounding at one of the afternoon meetings of the Society the view was expressed that the Langevin apparatus is too delicate and expensive (p. 48 of the present number of the *Journal*); but it would seem that the cost must have been reduced, as it is being fitted extensively on French trawlers; and we understand that by a working arrangement with the Marconi Company the maintenance of the transmitting and receiving gear, which are closely analogous to the apparatus which performs the corresponding functions in radiotelegraphy, can be undertaken by the ship's wireless operators. Other very interesting instruments in the French section were the continuous recording apparatus of M. Marti for the supersonic sounder, and a current meter of M. Idrac, with which he has been studying the Gulf Stream, and promises to send us some interesting results. The French section of the exhibition was in the energetic hands of Commandant Roussilhe, and was ready in a commanding position on the opening day, with a party of French naval ratings in attendance from the warship which had brought the exhibit to Seville. Not all the other sections were so well staged. Professor Pettersson's very interesting and important collection of new oceanographic instruments, and the formidable-looking current meter shown by the Germans, suffered in effectiveness from the unreadiness of their neighbours: the single British exhibit appeared to be derelict up to the close of the meeting. The honours of foreign exhibitors were all to the French. It is unnecessary to say that the home exhibit of the Instituto Español de Oceanografía gave full evidence of the excellent work carried on there under the direction of Professor Odón de Buen, to whose enterprise the Exhibition and the Congress are due.

The traditional hospitality of the Spanish people made noteworthy the reception by the Municipality, the excursions to Jerez and on the Guadalquivir, and the concluding banquet; and the special meeting at which General Primo de Rivera presided gave to the foreign delegates a welcome opportunity of expressing their homage to the King and their gratitude to the Spanish Government and nation.

A. R. H.

THE NEW ORTHOGRAPHY IN TURKEY

J. H. REYNOLDS

THE new Turkish alphabet in Latin characters consists of twenty-eight letters. It differs from the English alphabet in omitting *q*, *w*, *x* and in adding the consonants *ç*, *ş* and the vowels *ı* (without a dot), *ö*, *ü*. In addition the forms *ğ*, *â*, *î*, *û* are employed but are not considered to be separate letters of the alphabet.

Taking the consonants first, we soon come to the letter which will cause the greatest confusion and dismay to all foreigners. In no other language does *c* have the sound of *j* (English). In Teutonic and Romance languages it has the sounds of *k*, *s*, or *ch* (as in *church*), and in Slavonic (also in Magyar and Albanian) that of *ts*. It is clear that the framers of the new alphabet wished to avoid the use of more than one letter to express a single sound, and that they looked about for a pair of symbols to represent the Arabic ج and چ, which had the cognate sounds of *j* and *ch* (English). The use of *c* with a diacritical mark to represent *ch* is reasonable ; but it is to be regretted that the choice did not fall upon the now fairly familiar Slavonic *č* instead of upon *ç* with its well-established French and Portuguese value of *s* (even though this letter has been chosen by the Albanians to represent the sound of *ch*). Apparently the selection of *ç* for *ch* led the Turks to the choice of plain *c* for *j* (English). The letter *j* might have been used in the new alphabet with its English sound ; but actually it has been given the French sound and represents the comparatively rare Persian letter ژ=*zh*, practically non-existent in Turkish place-names and employed only in a few imported Persian and French words: *e.g. ejderha* for اژدرها=*ezhderha* (dragon), *jandarma* for ژاندرما=*zhandarma* (gendarme). As the French spellings are not adopted bodily, some other letter would have done as well as *j* to represent this rare sound of *zh*, the obvious solution being *ž* or *ʒ* (with a cedilla), as that would bear the same relation to *z* (ز) as *ş* (ش) does to *s* (س). However, it is no use now suggesting improvements in this alphabet. The damage has been done, and we must accustom ourselves to spellings like *Çatalca* for چتالجه, trying to remember that this is to be pronounced not *Satalka* but *Chatalja*.

The next letter in the new alphabet that calls for comment is *g*. This represents both غ=*gh* and گ=*g* (hard): *e.g. Yozgat* for یوزغاد=*Yozghad*, *Gerze* for گرزه. Sometimes these Arabic letters lose their consonantal value, غ becoming practically mute (like our *gh* in *throughout*) and گ having the sound of *i* in the second half of a diphthong; both are then written *ğ* in the new orthography: *e.g. ağaç* for اغاچ=*aghach* (tree), pronounced *a-ach*, *boğaz* for بوغاز=*boghaz* (throat, straits), pronounced *bo-az*, and *iğne* for ایگنه=*igne* (needle, thorn), pronounced *īne*, *Ereğli* for ارگلی=*Eregli*, pronounced *Ereili*. This letter *ğ*, however, cannot appear at the beginning or end of a word: *e.g. bey* for بگ, not *beğ*.

The letter *h* is used not only for the hard and soft aspirates ح and ه but also for خ, which is generally rendered by *kh* but pronounced by Turks as *h*. This is one of the unfortunate features of the new alphabet, as for most

foreigners it means a change in initial when this letter begins a word: *e.g.* *Harput* for خرپوط=*Kharput*.

Passing over *j*, which has already been dealt with, we come to *k*. This represents not only ک but also ق, which is the Arabic guttural often rendered by *q*: *e.g.* *Ankara* for آنقره=*Anqara* (conventionally *Angora*). It also appears to be used sometimes for غ, at any rate in the word *kuruş* for غروش=*ghurush* (piastre from the German *groschen*), usually pronounced *kurush*.

There is no distinction in the new alphabet between the guttural *n* (ڭ, called *saghir nun*) and ordinary *n* (ن): *e.g.* *yeni* for يڭی (new), *deniz* for دڭز (sea), where *n* is pronounced as *ng* in *singing* (by eastern Turks, though not at Constantinople).

The letter *s* represents the Arabic letters ص س ث, *t* ط ت (sometimes د), *z* ظ ز ذ, while ض is represented by *d* or *z* according to pronunciation (usually *z*). The letter *ş* has the same value as in Romanian, *i.e* *sh* (ش): *e.g.* *Eskişehir* for اسکی شهر=*Eski Shehir*.

It is a great pity that *y* is not employed exclusively as a consonant. But it also takes the place of *i* in the second half of diphthongs: *e.g* *Kayseri* for قیصری=*Qaisari*. There seems to be little justification for this usage.

Turkish vowels are divided into hard, *a*, *ı* (without a dot), *o*, *u*, and soft, *e*, *i*, *ö*, *ü*. The last two, *ö* and *ü*, have their well-known German values and require no further explanation. The letter *ı* (without a dot) approaches the neutral or indeterminate vowel as in the second syllable of the word *nation*: *e.g.* *Ayvalık* for ایوالق=*Aivaliq*. The adoption of this curious symbol will surely prove to have been a mistake; it is most confusing in lower-case print and script, especially when it comes after *l*, the combination being almost indistinguishable from the letter *h*. It may be noted that the ordinary *i* (with a dot) is to have a dot when it is in the form of a capital. It may also be mentioned here that when a final ی=*i* is pronounced like و=*u* it is to be written *u*: *e.g.* *Gelibolu* for گلیبولی (conventionally *Gallipoli*).

The use of the circumflex ^ with the vowels *a*, *i*, *u* is a little difficult to grasp, as it appears to have one of three effects. (1) It sometimes lengthens the vowels, but can be used in this way *only* when it is desired to make a distinction between two words of different meanings which would otherwise have the same orthography: *e.g.* *âlem* for عالم (world) and *alem* for علم (flag). (2) It palatalizes the vowels *a* and *u* after the consonants *k* and *g*, causing them to be pronounced *ya* and *yu*: *e.g* *kâr* for کار (profit), pronounced *kyar*, but *kar* for قار (snow). Over a vowel after *l* it removes the guttural sound of this letter which approaches the broad Gaelic or hard Russian *l*. (3) Final *î* appears to be used as an attributive suffix in the formation of an adjective from a substantive: *e.g.* Farisî for فارسی (Persian), from *Faris* for فارس (Persia).

There remains the apostrophe ', which can be used to indicate a break in pronunciation, representing either the Arabic *'ain* ع or *hamza* ء: *e.g.* *mes'ut* for مسعود (happy), *mes'ele* for مسئله (question). But this sign seems to be used sparingly. In general both *'ain* and *hamza* are ignored in the new ortho-

graphy, as they are not usually pronounced by Turks except as deliberately foreign sounds.

It is probable that many Turks are not yet perfectly familiar with their new alphabet; it is certain that caution must be used with some of the pamphlets that profess to set it forth. The construction of an exact table of transliteration from the Arabic to the new Latin characters is impossible; but this is the fault not so much of the Latin as of the Arabic characters, many of which were quite unsuited to represent Turkish sounds. Only a good knowledge of the language can determine whether vowels are hard or soft, and whether *g* is pronounced as a consonant or not. Until the publication of official maps in the new characters geographical examples cannot be given with any certainty. When the new maps are available, a list of names in Turkey can be undertaken by the Permanent Committee on Geographical Names. Whether that body will decide to adopt the new spellings without modification remains to be seen; the letter *c* is the worst stumbling-block. The position is complicated by the question of Turki, which closely resembles Turkish. One of the reasons for the adoption of *q* for the letter ق in Turki was that it was used in the transliteration of Turkish. Thus, the P.C.G.N. decided to write *aq* (white) and *qara* (black) [*G.J.* 65, 247]; but these have now become *ak* and *kara* in the new Turkish orthography. Then, of course, many Arabic words are used in Turkish; we must accustom ourselves to seeing them spelt one way in, say, Egypt and another way in Turkey. Here it may be noted that all compound names are to be written as single words: *e.g. Ras el 'Ain* now appears to be spelt *Resülayn* in Turkish. There has been, however, for some years a movement to abolish Arabic and Persian words from the Turkish vocabulary as far as possible; and attempts are made to disguise in Turkish form those that are retained.

THE EARLIEST AMERICAN MAP

THE FIRST DELINEATION OF THE NEW WORLD AND THE FIRST USE OF THE NAME AMERICA ON A PRINTED MAP. By HENRY N. STEVENS. *London: Henry Stevens, Son & Styles* 1928. 13×10 *inches;* xvi +128 *pages; and facsimiles.* £2 10*s*

IN this work Mr. Henry Stevens has at last submitted in detail the grounds of his claim that the map discovered by him a quarter of a century ago, and now the property of the John Carter Brown Library at Providence, R.I., is the earliest map not only to bestow the name America on a part of the New World, but to show in printed form the new discoveries of Columbus and his successors. The claim was put forward in an article by Mr. Basil Soulsby in this *Journal* (February 1902), itself suggested by the then recent discovery of Waldseemüller's great map of 1507; and, as Mr. Stevens allows, the present memoir has finally taken shape largely through the discovery of the Contarini map of 1506, and the article thereon in the *Journal* for October 1923. In this article the priority for representing the new discoveries on a printed map was tentatively claimed for that Italian document.

It may be recalled that the Stevens–John Carter Brown map (which like its discoverer we may hereafter quote as the S–JCB) bears a very close resemblance to the Marine Chart of the World given in the 1513 Ptolemy, brought out at Strasbourg under the editorship of Essler and Ubelin; in fact, it is only on a careful inspection that the differences become manifest. One is the presence of the name America, not found in the 1513 issue, and another is the fact that with very few exceptions the place-names are printed from type let into slits in the engraved wood-block. By an intensive study of the type and paper Mr. Stevens was led to think that his map represented the original version prepared by Waldseemüller and his colleagues at St. Dié in or before 1507, when planning a new edition of Ptolemy's geography, and that on other grounds too it might be placed before the big map of 1507, and would therefore have the interest of a first representation of the features shown on it. In the present memoir Mr. Stevens brings forward more detailed arguments in support of his claim, turning the subject over and over and looking at it from every possible angle. This involves a good deal of repetition, and some may feel that the arguments would have lost none of their force if rather more concisely stated.

It may be said at once that the reasons for a date before 1513, when the better-known version appeared, seem fairly conclusive. The proved use of the same type and paper at Nuremberg in the first decade of the century; the appearance of *additional* names in the 1513 version; the general use of inserted type for the S–JCB map alone of those prepared for the Ptolemy—indicating that it was a trial effort, while the piercing of the wood for the type, by rendering it liable to split, would explain the need for subsequent re-engraving: these points taken together have a cumulative force which renders it unnecessary to discuss the question in detail. The priority over the big map of 1507 may also be conceded as probable, though not quite so firmly established. The statement of Gualtier Lud, one of Waldseemüller's colleagues at St. Dié, in his 'Speculi Orbis declaratio' (a treatise written to explain a now lost map or other document, the precise nature of which is unknown), shows that quite early in 1507 the coterie at St. Dié had in preparation a new edition of Ptolemy, and also that a map showing the new western discoveries had before that been "hastily prepared," though whether it was actually printed or even engraved is left uncertain. It is naturally tempting to the discoverer of the S–JCB map to regard the latter as possibly representing this hastily prepared map, though the suggestion is not

unduly pressed, and is hardly consistent with the writer's subsequent laudation of the map as the first example of a printed hydrographical map showing the new discoveries up to date. Besides, the terms of Lud's reference seem rather to imply that the hastily prepared map was a special map of the American discoveries that might, he admitted, have suitably taken the place of the special map of Europe actually supplied. (As the speculum itself displayed the whole world there would be the less need of another general map.)

While we have no wish to dispute the probability that the S–JCB map was prepared, and perhaps engraved, before 1507, the arguments for a possible date of 1505 can hardly be thought conclusive, as they depend largely on the condition of the type when the block was prepared. Until the discovery of the Contarini map of 1506, Mr. Stevens seems to have been content to regard his map as probably of that year. In support of his theory he has much to say about the Latin preface "Ad Lectorem" of the editors of 1513, with its obscure reference to the aid given by Duke René of Lorraine (who died in 1508) towards the preparation of some of the maps. Besides giving a facsimile and translation of this preface, he brings together the comments of fourteen previous writers on the passage in question, and finds that they have all alike missed its true sense. He criticises them for interpreting the passage in so many different ways, remarking that Latin must be a convenient language when two commentators find two opposite meanings in the same passage. But considering that the Latin is merely that of two German editors, and that its construction is anyhow faulty and involved, one may ask whether it is likely that its precise meaning (if it had one in the minds of its writers) can ever be established with certainty. The glaring mistake of calling the King of Portugal Ferdinand is plausibly explained by the suggestion of Mr. Barwick (to Mr. Stevens) that certain words had accidentally dropped out. (This had occurred independently to the present reviewer.) Mr. Barwick would read the clause as "Admiral at one time of the . . . king of Portugal *Manuel, and afterwards of the . . . King of Castile* Fera...and," the italicized words being those supposed to have dropped out. This gets over the difficulty well, and the probable reference to Vespucci would be particularly apposite in view of his change of service. Anyhow the idea that Columbus was the Admiral referred to may be dismissed as improbable (as it is by Mr. Stevens).*

In reference to the help given by René Mr. Stevens reiterates two conclusions with great insistence: (1) That the marine chart spoken of is not the *Tabula Terre Nove* as some have rather carelessly supposed, but the general chart "after the system of Hydrographers" (as its title describes it); (2) that what René did was to make publication possible by helping to bear the expense, and not by supplying maps or other documents. In regard to (1) he is no doubt literally correct, but the great importance of the distinction is not very obvious, though we can understand the added value thereby given to the one item in the eyes of its discoverer. He himself admits that the special American map, with four other modern maps evidently based on Portuguese sources, were not only among the first to be prepared, but were among those associated with René's name; and since it is evident that these special maps have a common origin with the general map (as regards the new discoveries), there seems no real

*The use of Portuguese sources by the German mapmakers of the time has been well brought out by Harrisse in his work on the Discovery of North America, and the special influence of Vespucci is insisted on by Magnaghi in his work on the Florentine reviewed in the *Journal*, vol. 66, p. 339. But as the map embodies the new discoveries in Asia and Africa as well as America, it is conceivable that some other Portuguese navigator—even Vasco da Gama—might be intended.

justification for treating this last as on quite a different plane from the rest. On point (2) again we confess to being not altogether convinced. The general tenour of the Latin, and especially the use of the word *tradita* in reference to René's action, certainly seems to imply that something (whether documents or maps) was actually handed over by René for the use of Waldseemüller and his associates. And when we find that the maps in question bear a close resemblance, in their delineation of the new discoveries, to maps like the Canerio and Cantino, dating from about 1502, we cannot see that Mr. Stevens has seriously invalidated the suggestion of Professors Fischer and Von Wieser that either the Canerio map itself (of which Waldseemüller published a close copy in 1516) or another of its type, was already in the German cartographer's hands when preparing the new maps for the projected Ptolemy.* In this case the *Tabula Terre Nove*, with its much fuller details in its own field, would be little less important than the Hydrographical chart, though, since no original copy of the former has unfortunately come down to us, as an actual document that can be handled the general chart may no doubt claim priority. Even this is not an absolute certainty ; for if one more guess may be allowed where all is largely guesswork it is just possible that some at least of the maps may actually have been printed off at St. Dié before coming into the hands of the Strasbourg editors; for quite a number are printed on the very same paper as was used for Waldseemüller's big map of 1507.

In the second part of the memoir the author enters very fully into the question of priority as between the S–JCB map and Waldseemüller's of 1507. As we are prepared to admit the probable priority of the former, we need not say more on this head. The third part discusses the like question as between the S–JCB map and Contarini's, and we admit that the former *may* be the earlier without agreeing with Mr. Stevens that this is definitely proved. He certainly scores a point by showing that even if published in 1506 the Contarini map may have been little in advance of Waldseemüller's of 1507, for as the year 1506 in Florence *may* have gone on until March of the year elsewhere regarded as 1507, while Waldseemüller's map seems to have been ready for issue in April, 1507, the interval may have been one of but a few weeks. In claiming in 1923 that the Contarini map was a year earlier than the other the present writer had no thought of implying that there was a full year between them, but merely that the one had been made during the year before the other appeared. And as Mr. Stevens says, the *inception* of the larger work may well have been the earlier. It is to be feared that the question will never be settled definitely.

We have ventured to differ from Mr. Stevens on certain points, but we gladly recognize the amount of painstaking research embodied in his memoir, which, from the careful references supplied, will be of permanent value to students of early cartography. It is brought out in an imposing style, is excellently printed on paper of the first quality, has a full index, and contains in a pocket reproductions of the two versions of the Hydrographical map under discussion.

E. H.

*Mr. Stevens seems anxious to prove that what was due to René's liberality was the actual hydrographical chart as known to us. But surely the editors of 1513 would be quite justified in speaking of their map as originally handed over by René, if he had supplied the document from which it was copied. An explorer's map is no less his own because it has been put into shape by a draughtsman at home.

REVIEWS

FINNLAND: Land und Volk-Geschichte-Politik-Kultur. By JOHANNES ÖHQUIST. II. Vermehrte und umgearbeitete Auflage. *Berlin-Grünewald: Kurt Vowinckel* 1928. 8×6 *inches;* x+258 *pages; maps.* 8.50 *Marks*

This compact and neatly summarized work, containing a well-balanced and appreciative account of Finnish life and character from every point of view, should prove not only an indispensable source of information for the student of Finland, a country old and yet new, but also a useful commentary on the autogenous development of the modern civilized state.

The subject-matter falls into five main sections: the land and its people, history, the constitution, industrial life, intellectual development.

The description of the land occupies twenty-three pages only, so to the student of physical geography the book can make little or no appeal. The features of a country extending over more than 10 degrees of latitude cannot be summarized satisfactorily in a page, and a geological description dealing with formations so complicated, when compressed into six pages, is hardly intelligible to other than an expert. To the student of political geography or social science, however, the remaining 223 pages of the book will be wholly satisfying.

The description of the race and its origin is precisely given, the fact being well brought out that the somewhat conflicting types of character emergent in east and west have been happily amalgamated, partly through the unifying influence of the "Kalevala," or traditional poetry of Finland, collected from many sources and put into epic form by Lönnrot. The peculiarities of the language are cleverly touched on, including the fifteen cases without prepositions in the declension of nouns (bewildering to the tourist at a railway station, anxiously desirous of knowing which is "to" and which "from"); the compensating complete regularity of the verbs; the change in consonant according to its position (reminiscent of Welsh); the placing of the accent uniformly on the first syllable and the strictly phonetic spelling; and, the elimination of consecutive consonants in foreign words (*e.g.* "lasi" for "glass"), this and other characters giving to the language a fluidity which renders it particularly well fitted for purposes of declamation and song.

There follows a brief, impartial account of the two-race difficulty, one-eighth of the population being Swedish in speech but Finland born. Great has been the consolidating and stabilizing effect of this Swedish minority; the writer points out, moreover, how the poet Runeberg has helped to promote a mutual understanding between the two peoples, so closely bound together in past tradition and present need. No aspect of social life or political development is slurred over or omitted: for example, the effect of topographical features on population; the attempt by means of legislation ("lex Kallio") to meet the requirements of the landless; the conditions of housing; and landownership. Amongst these, the position of women calls for special comment, and the vexed question as to the efficacy or otherwise of the prohibition law is suggestively handled. The account of legislation dealing with unemployment, child-welfare, and the equivalent of Poor Law regulations reveals the comparative simplicity of these problems in a country unshackled by past tradition and unburdened by a huge superfluous population.

A very brief summary of Finland's past history suffices to portray the indignities suffered by this unfortunate country in serving as a bone of contention between Sweden and Russia. During the 650 years of Sweden's supremacy periods of peaceful development occurred, and then, under a wise government,

a certain amount of autonomy was allowed. When therefore, in 1809, the whole country passed by conquest into the hands of Russia, the feeling of individual and national consciousness, already latent, sprang into life and conditions were made securing the continuance of this autonomy. From 1899 onwards these privileges were one after another withdrawn, until the resultant unrest culminated at last in stroke and counter-stroke by which, in the later war years, freedom was at last achieved. The author describes the process attending the development of the new state, its method of government, its finance, its methods of taxation, its religion, and its modes of defence. The various religious parties are then mentioned and explained, their numerical strength in 1907 being set out in tabular form. Very important and interesting descriptions of industrial organization, again with statistics, are given and are followed by regulations with regard to time, weights and measures, customs, transport, and postal services.

The book closes with chapters on Finnish culture, showing the very high position allotted to educational development in this state. The author enumerates the many writers, Finnish and Swedish, who have contributed to build up Finland's heritage of national song. The various sides of artistic expression are touched on, culminating in the remarkably sudden development of a native architectural style distinguished not only by a grand simplicity of line, but also by a masterly handling of material. A useful list of books on Finland concludes the volume, except for a few maps, the only attempts at illustration. The maps however, except for two agricultural charts, bear little relation to the text. There is a useful index. E. G. W.

THE SILKEN EAST: A Record of Life and Travel in Burma. By V. C. SCOTT O'CONNOR, with an Introduction by Sir HARCOURT BUTLER. *London: Hutchinson & Co. Ltd.* [First cheap edition 1928.] 9×6 *inches;* 384 *pages; illustrations.* 21*s*

Mr. Scott O'Connor has been described by a critic as the traveller's poet. He writes of what he has seen pleasantly, simply, and accurately, but with just that poetic touch, born of sympathy and insight, which places his work in a class of its own. 'The Silken East' is perhaps the best of his works, and has long been appreciated as a leading work on Burma. In this issue of a second edition at a lower price the book has been left substantially unchanged; the introduction by Sir Harcourt Butler strikes a modern note, but the work remains a perfect pen-picture of Burma a generation ago. It would be possible to point to many details which are no longer true—one may often add, unfortunately—but one is glad the author has not attempted to modernize his description. Thus Rangoon has long since passed a quarter of a million inhabitants and learnt to rely on other sources of water than the Victoria Lakes; it may surprise many to know there were ever Chinese rickshaw coolies; it seems strange to read of Singu that "the oil company at Yenangyaung will shortly begin operations here" when Singu is now producing nearly 100,000,000 gallons a year. But there are few who have lived in Burma who will not be able to say with the author, "Many years have elapsed since I first went to Burma, yet the memory of that time remains fresh and vivid in my mind, and as I read these pages I forget that I am in England. . . . For those were happy days. Drop a young man of say twenty-three into a land more extensive than France, double his pay, and give him licence to travel through it from China to Malay; tell him you trust him to play the game; assume that he has some love of beauty and sufficient health, and if he is not going to be thoroughly happy he never will be."

Though obviously dating from the closing years of last century much of the

picture remains true at the present day: no visitor to Burma could do better than to take with him this volume and to appreciate or deprecate for himself modern changes. Before he decries the supposed laziness of the Burman it is well to remember "there is also the laziness of the man with a fine physique, with a sporting nature that exults in athletic expression, in racing, swimming, boxing, and rowing; of the man whose mind is full of lively fancy, of wit, even of creative power; of the man who enjoys life and finds in it infinite possibilities of amusement, of love, of good fellowship; of a man who has fashioned for himself a goodly standard of life and lives well with little toil; above all, of a man whose being is permeated with a philosophic contempt for the accumulation of material things, with a generous desire to bestow in charity and in good works all that is over and above his own needs. Much of the laziness of the Burman is of this type. It is reflected in his life." L. D. S.

LE THANH HOÁ: ÉTUDE GÉOGRAPHIQUE D'UNE PROVINCE ANNAMITE. By CHARLES ROBEQUAIN. 2 volumes. *Paris and Brussels: G. van Oest* 1929. 11×7 *inches;* 251, 626 *pages; illustrations, diagrams and maps. Subscription price* 200 *francs*

The Ecole française d'Extrême-Orient is to be congratulated on its valuable series of ethnological and geographical publications, of which the present work constitutes the twenty-third and twenty-fourth volumes and well maintains the scientific and scholarly standard of the others. The province of Thanh Hoa is roughly triangular in shape, the apex of the triangle being at the junction of the Song Ma and the Nam Xim rivers and the base on the gulf of Tonkin—an area of 10,850 square km. (larger than the largest department of France), with an estimated population of 850,000. M. Charles Robequain devotes his first volume to the hinterland, which is inhabited mainly by the Thai and the Muong, and his second to the delta country, which is peopled almost exclusively by Annamites. After a detailed study of the climate of the province as a whole, he gives a geographical description of the hinterland and then proceeds to deal with its principal ethnological groups, their social organization, agriculture, habitations, industries and trade, following a similar procedure in the second volume, which is much longer, owing to the Annamites having reached a higher standard of culture than the hill folk; and he concludes with a section on the work of the French Colonial administration, describing what it has accomplished for the province in the past forty-five years.

M. Robequain's work is as precise as it is comprehensive. It is well documented throughout and includes an exhaustive bibliography, while the maps are excellent, particularly that which shows (in colour) the ethnological distribution. But for the fact that it lacks an index the book might be called a model of its kind, and it must take its place as a standard work on this important province of Annam. O. R.

SUDANESE MEMOIRS: being mainly translations of a number of Arabic Manuscripts relating to the Central and Western Sudan. By H. R. PALMER. 3 volumes. *Lagos: The Government Printer* 1928. 10×7 *inches;* 82, 120, 164 *pages; illustrations and maps*

Mr. Palmer's latest work forms an important contribution to the literature of Western Africa. The ethnologist and historian will find in these three volumes a mass of fresh material which is out of all proportion to their slender form and humble garb. They comprise a large number of translations of manuscripts which have mostly been collected in the northern emirates of Nigeria, but they owe more than half their value to the erudition of their editor. As in previous

publications of a similar character, Mr. Palmer has placed the student greatly in his debt by the information he gives in his introductory and explanatory notes.

Mr. Palmer, however, is unfortunately prone to assume that his readers share with him his own unique knowledge of his subject, and therefore his arguments are often very difficult to follow through the mass of material which he crowds into every paragraph. Similarly, he seems to take for granted that his readers are sufficiently familiar with the Arab authors for it to be unnecessary to give chapter and verse when he quotes them in support of his arguments. If one needs to be somewhat of an enthusiast fully to appreciate the value of his work, ample reward awaits the reader who will give the time and trouble necessary to master all that Mr. Palmer has to tell. His methods can only be partly excused on the grounds that his work is primarily intended for a few enthusiastic students.

The first volume, which is the least interesting of the three, continues the story of the reign of Mai Idris Alooma of Bornu, which Mr. Palmer began in a volume published in 1926, the text being again from the manuscript which Barth procured for the Foreign Office in 1853. It is mostly an account of seven expeditions made against Kanem between the years 1570 and 1577 and, apart from the mention of a Turkish embassy to the Sudan, contains little of more than local interest.

The forty-four manuscripts which comprise the second volume " are mostly concerned with the tribal legends or traditions of the Chad area and countries lying to the east of south-east of it in the Sudan belt." Mr. Palmer's unrivalled knowledge of the country and its history has enabled him to unravel the tangled story which these records tell and to add considerably to our knowledge of this region. Although these manuscripts relate directly only to Bornu and Hausaland, indirectly they have an important bearing on the history of the whole of Northern Africa. Out of the wide variety of interesting subjects which are discussed by Mr. Palmer, it is now only possible to dwell upon certain points of outstanding geographical interest.

In his introduction to this volume Mr. Palmer goes some way towards settling the controversy which has so long centred round the names of Kaugha, Kaukau, Kukia and the two Gao's—Gao on the Niger and Gao near lake Fitri, to the east of Chad.

According to Idrisi the distance from Kaugha to the town of Kaukau "going north" was twenty journeys by camel. This passage has led most authorities to assume that Kaugha was Kukia, the ancient Songhai capital, and that Kaukau was the later capital Gao (on the Niger). Mr. Palmer points out that the passage in Idrisi is probably corrupt and that the words "going north" have crept in, perhaps from some marginal note. He thinks therefore that the Kaugha of Idrisi was the Gao near lake Fitri, and that Kaukau was the ancient Kukia. It has been generally thought that Kukia was somewhere on the Niger. Desplagnes and Delafosse were more precise and, for little apparent reason, placed it on the island of Bentia between Gao and Tilaberi. Cooley inclined to a more easterly situation. Idrisi's description of it on an intermittent stream running through desert suggested to Mr. Palmer a situation on one of the dry watercourses which fall into the Niger on its left bank between Illo and Sai, in the country of Dendi. Now Dendi is the traditional centre from which the Songhai extended their dominion over the middle Niger. Moreover, it used to be included in the Kingdom of Kebbi, a state which dates from the sixteenth century when its chief revolted against his Songhai overlord and took the title of the ancient kings of Kaukau, which was Kanda, now pronounced Kanta. "Under these circumstances," writes Mr. Palmer (vol. 2, p. 21), "it is a fair supposition that the Kantas (Kandas) of Kebbi were in some sense the cultural successors of the

Kandas of Kaukau, and secondly that the ancient Kaukau, which lay in the Songhay province of Dendi, was situated in the country which later became Kebbi rather than in the riverain portion of Dendi, which never came under the authority of the Kantas of Kebbi."

Inquiries in the Kebbi emirate have led to the information that "a ruined city called Kaukau, which lies north-west of the present Kebbi capital, Argungu, and not far from the present town of Beibei, is regarded as the oldest city in that part of the country." Mr. Palmer believes this to be the site of the ancient Songhai capital. This ruined city is on a branch of the big wadi called the Dal ul Mauri, which was probably once a river, a situation which, Mr. Palmer claims, entirely corresponds with El Bekri's description. This claim, however, depends upon the assumption that not only the Dal ul Mauri but also its branch were rivers in the eleventh century, of which there is no direct evidence. Nevertheless the strength of Mr. Palmer's case cannot be denied, and it seems probable that he has made a most valuable contribution to our knowledge of the history of the Western Sudan by definitely locating the ancient Songhai capital.

In view of the known fact that the ancient Kaukau was much frequented by foreign merchants, it is interesting to note that objects found in Kebbi and now in the British Museum were declared by the late Sir Hercules Read to show North African influence.

Volume 3 begins with several "Mahrams" or grants of privilege, mainly of local interest, and continues with two valuable accounts of Ahir (Asben) and the important Kano Chronicle, to the publication of which we have long looked forward. It ends with a history of the ancient Hausa state of Daura, contributed by Mr. A. E. V. Walwyn.

In this volume Mr. Palmer discusses the situation of the mysterious Guangara or Wangara placed by Leo Africanus in Hausaland. Mr. Palmer points out that the Chafi–Kwotorkoshi–Kogo region which lies "due north" of Zaria (north-west would have been more accurate) is universally said to be the Katsina famous for its learning and commerce as distinct from the present Katsina, which is much farther north. "It is evident," he continues, "that the region which Leo Africanus (1528 A.D.) calls Guangara (Wangara) which lay in Hausaland south-west of Zanfara . . . was no other than this very region of Katsina Laka." According to Leo (Hakluyt Society's Edition, p. 831), "This kingdome (Guangara) adjoineth southeasterly upon Zanfara." The passage is admittedly ambiguous and might mean that Wangara was south-east of Zanfara or Zanfara south-east of Wangara. It evidently confused the cartographers who followed him from Blaeu in 1635 to De Lisle in 1792, some reading it one way and some the other. It cannot be read to mean that Wangara was south-west of Zanfara, where Mr. Palmer puts it, and if it did it would afford but slight excuse for supposing Katsina Laka to be Leo's Wangara. It is perhaps worth pointing out that if throughout Leo's very confused description of Hausaland we read "west" for "east," and "south-west" for "south-east," and thus reverse the relative positions of Kano, Katsina, Zaria, and Zanfara, we get a surprisingly accurate result, a discovery we made by looking at Blaeu's map in a mirror. As Mr. Palmer gives no other reason for supposing that Katsina Laka was the Wangara of Leo, we cannot accept this solution of the problem.

We do not think, however, that any elaborate explanation is necessary. Leo seems to have had no doubt in his mind that he was describing the famous gold-producing Wangara of the Arabs, which we now know to have been in the Mandingo country beyond the Upper Niger, for he tells us (p. 832) that "southward there lieth a region greatly abounding with gold" with which it traded. A more probable explanation seems to be that while travelling through Zanfara

he heard of a neighbouring settlement of Wangarawa, who were then widely scattered through the Western Sudan, and fell into the error of believing their town to be the famous Wangara of history. If this explanation is accepted, it ceases to matter which particular settlement of Wangarawa Leo was referring to.

In the same volume Mr. Palmer gives us an interesting note on the voyage of Hanno. He thinks that the Lixitae, who were nomad pastoralists, spoke Fulfulde, or a tongue akin to it. He bases this supposition on the fact that *gorel* is still the existing Fulfulde diminutive for man, and was probably used by the Lixitae to describe the gorillas or whatever it was they saw.

This work contains so much important information bearing directly on the ethnology and history of the whole of Northern Africa that it is greatly to be hoped that the material it contains will one day be made available to a wider public than that for which the present volumes are intended. Its value would be greatly enhanced by a more liberal supply of maps and a proper index. It is moreover worthy of something better than the format which we have learnt to associate with the publications of the Government Printer at Lagos.

E. W. B.

REPORT ON MALAYA, CEYLON, AND JAVA, 1928. By the Rt. Hon. W. G. A. Ormsby Gore, M.P. *London: H.M. Stationery Office* 1928. 9×6 *inches;* 166 *pages; three maps.* 4*s* 6*d*

This is the official report of a visit made last year to Malaya, Ceylon, and Java by the Parliamentary Under-Secretary of State for the Colonies. The chief object of these tours is to bring the Colonial Office into more direct touch with problems of Colonial development and administration, and in preparing his report Mr. Ormsby Gore has selected for publication those features which may be of value and help to other Colonial Administrations. His itinerary shows that he made the best possible use of his time during his two and a half months' tour in the countries under review, and the report is packed with precise and detailed information. In the chapters on Malaya and Ceylon the subjects of agriculture, public health, education, forestry, and transport are reviewed in turn, and a special chapter is devoted to the rubber industry, which, the author is convinced, depends on research rather than restriction for its prosperity. O. R.

OLD RHODESIAN DAYS. By Hugh Marshall Hole, C.M.G. *London: Macmillan & Co. Ltd.* 1928. 9×6 *inches;* x+140 *pages; illustrations and map.* 10*s* 6*d*

It is now forty years since the Pioneer Column entered Mashonaland, and in 'Old Rhodesian Days' Mr. Marshall Hole tells the story of the first dozen years or so of Rhodesia's existence: of the manner of life of the pioneers, their shifts and makeshifts; of the "characters," great and small, to be met with—the great including "Loben," "Dr. Jim," and Cecil Rhodes; and of the tragedy and heroism of the rebellion of 1896. As an official of the Chartered Company the author went to Mashonaland almost immediately after the Pioneer Column, and he writes of what he knows, as his book 'The Making of Rhodesia' amply showed. Here he has gathered together stories and incidents not considered suitable for a political history, his modest aim being "to recapture a little of the atmosphere which surrounded the early settlers." He has achieved his aim completely, the atmosphere is there—indeed, reading his pages we live and move among those early Rhodesians. Of the two books we would almost rather be without 'The Making of Rhodesia' than this later volume.

The number of good stories—all of which we firmly believe to be true—Mr. Hole tells is astonishing. One of the best concerns Jameson as Chief Magistrate.

The "Doctor" was trying a case of fraud brought by one Indian coolie against another. Convinced that it was a trumped-up charge brought vindictively, Jameson sentenced the *prosecutor* to receive ten lashes and several of his chief witnesses five lashes each, "a startling but admirably just decision." There is also a fine and thrilling account of the plight and rescue of the settlers at Mazoe during the rebellion of the Mashona. F. R. C.

HISTORY OF NIGERIA. By A. C. BURNS, C.M.G., Deputy Chief Secretary to the Government of Nigeria. *London: George Allen & Unwin Ltd.* 1929. 9×6 *inches;* 360 *pages; maps.* 15*s*

There has long been wanting an authoritative history of Nigeria, the importance of which in Imperial affairs is still insufficiently appreciated. Probably very few people in Nigeria itself realize that the country has a population greater than that of Canada, Australia, and New Zealand combined. Numbers of volumes have been published about its native races, its administration, its geology, and the adventures of its officials, but till now we have had no dependable account of its history. The reason no doubt is that Nigeria is a comparatively recent acquisition and scarcely enough time has passed for its early years to be viewed in perspective. Nevertheless, there has long been need for a volume embodying information for which Government reports and Blue Books have hitherto been the only source.

The omission has now been made good by Mr. A. C. Burns, one of the senior administrative officers of the dependency, in an admirable volume which is a model of what such works should be. A compilation of this character entails a great deal of tedious work, and no small effort is required to attain the high degree of accuracy which Mr. Burns has achieved throughout this volume. He is commendably punctilious in quoting his authorities, which renders his work of particular value to students of Imperial affairs, but the omission of a bibliography is to be regretted and should be remedied in a second edition.

The greater part of the volume is devoted to pure history—the slave trade, the exploration of the interior, the dawn of administrative control, the growth of the Niger Company, the conquest of the northern emirates, and the creation of the enlightened system of government which will always be associated with the brilliant administration of Lord Lugard. To this are added valuable chapters on religion, education, land tenure, the judicial system, communications, trade and industry, with useful appendices giving the texts of various important treaties with native states. The general reader will find much to interest him in this brief but eventful history of a great dependency. The account of the slave trade, the description of the fetish-ridden city of Benin, and the story of the conquest of the Fulani emirates make enthralling reading.

E. W. B.

THE AGRICULTURAL DEVELOPMENT OF ARID AND SEMI-ARID REGIONS: with special reference to South Africa. By H. D. LEPPAN. *South African Central News Agency* 1928. 9×6 *inches;* 280 *pages; sketch-maps.* 25*s*

DIE KÜNSTLICHE BEWÄSSERUNG: die Bewässerungsmethoden und Systeme aller Erdteile. By PAUL HIRTH. Beiheft 1 zum *Tropenpflanzer. Berlin: Kolonial-Wirtschaftliches Komitee* 1928. 9×6 *inches;* 156 *pages; maps.* 5 *Marks*

These two essays in the scientific study of land, and more particularly of "dry-land," development form a most welcome addition to the growing literature of the subject. Both authors lay emphasis upon the fundamental and abiding importance of geographical factors, and though the areas involved and the subject-

matter are not identical in the two cases, there is sufficient coincidence to render comparison fruitful, the more so since Dr. Hirth seeks carefully to define and delimit the scope and method of his inquiry in the interests of theoretical precision, while Professor Leppan, more directly and practically concerned with the areas he studies, seeks to present in their full complexity living and developing situations.

Professor Leppan's book has been introduced to us to some extent by his earlier studies (*vide G.J.*, May 1924, pp. 448–449; and Plummer and Leppan: 'Rainfall and Farming in the Transvaal,' 1927). It embodies the results of research applied broadly in the field of agronomy, results the more valuable because the intimate interaction—almost "interbreeding"—of geographical and economic factors is everywhere skilfully analysed and revealed. First the Union of South Africa is studied regionally in respect of its agricultural and pastoral industries. The growth and present (1926/7) development is analysed in relation to the geographical background and due weight is given to historical, social, and economic factors. This survey is reinforced by a parallel study of some other areas held to be comparable in certain defined respects: the Bombay Presidency; Australia, and relevant portions of the United States. The conclusions are then applied, not without some rather wearisome iteration, to South Africa; an estimate of its potentialities is arrived at, and indications as to probable or desirable trends of progress are given. The work is obviously based upon solid study, supported, in the case of the Union and of the United States, by direct observation. The reasoning is careful and close, and if the conclusions as regards the Union are not optimistic they seem largely justified by the premises stated. The sections dealing with the other areas are more summary, and that dealing with Australia misses some useful points and hardly represents the present situation. That a work so valuable should be marred by formal defects is a pity. Ignoring misprints, mis-spellings, and the two rather poor sketch-maps, the writing is often slipshod to the point of obscurity, and one is driven to suppose that proof revision was not possible. Some errors are obvious (*e.g.* p. 202, "directly" for "inversely"; p. 154, Komatipoort temperatures, "May–Oct." for "Oct.–Mar."; p. 209, "Apr.–Sept." rainfall for "Sept.–Apr.," etc.). But we may express the hope that geographers in general do not stand in need of the admonition administered them on p. 74, especially as the relative merits of "average" and "extreme" meteorological figures in relation to agriculture are, we believe, diversely regarded by the agricultural experts themselves. Such defects, however, detract little from the general interest and value of this book, and geographers will be glad that the author at any rate did not believe that "the time spent on this subject might have been employed to better advantage on some specific agronomic problem."

Dr. Hirth's study of irrigation was composed as an academic "Dissertation." A valuable, and perhaps the most original, portion of this paper has become familiar through an article (*Petermanns Mitteilungen*, 1926, No. 7/8) in which the conception of "isonotides" was put forward and made the basis of a very interesting map. The conception has been criticized (*vide Meteorological Magazine*, Oct. 1926; *Geog. Zeitschrift* 1929, No. iii), and the author is not unaware of some of the difficulties, but for the study of irrigation the "isonotides" have probably a definite, if partially tested, value. The same striving towards scientific definition and precision marks the thesis in general; even the rather abstract analytic and classificatory reasoning of Part I is suggestive to such as will follow it. Part II—a regional survey of the distribution of irrigation over the globe—is uneven in value. Some parts are well informed; others

(*e.g.* the section on the Union of South Africa, and that on Australia) can only be described as antiquated. Even the closing of the list in 1921 hardly justifies a great majority of the 244 references cited dating from 1890–1906. A strict and mainly physical view is taken of the content of the geography of irrigation, and some interesting aspects (*e.g.* the settlement forms and economic integrations) associated with it are, apparently purposely, omitted. None the less the work will be welcomed by such as are interested in this and cognate subjects.

O. H. T. R.

THE SAILING-SHIP: Six thousand years of history. By ROMOLA and R. C. ANDERSON. *London: George Harrap & Co.* [*Reprinted* 1927; *first published* 1926.] 9×6 *inches; 212 pages; illustrations.* 7*s* 6*d*

So many books have been written about sailing ships during the last few years that many people will learn with surprise that no such British deep-sea craft have been launched for nearly a quarter of a century, although, it is true, the great Danish training-ship, *Kobenhavn*, which has lately disappeared in such strange circumstances, was built at Leith in 1921. By the year 1928 only one ocean-going sailing ship remained under the Red Ensign. There seems, therefore, a somewhat pathetic fitness in the appearance of the volume before us, dealing as it does with the origins and development of sailing craft in general during the sixty centuries of their known existence, and incidentally with those of our own navies. The authors realize that their attempt can be "little more than a summary," but it must be conceded that this summary, within its limits, appears singularly accurate and complete.

Reference is made to the Cornish legend that St. Ia floated over from Ireland on a leaf, as embodying a natural description on the part of a people accustomed to relatively large wooden vessels, of a small coracle built of green wood. This offers an interesting parallel to the Japanese legend of the voyage of the famous first climber of Fuji-San, the mountaineer-saint En-no-Shōkaku, who is stated to have made his way to China at the beginning of the eighth century A.D. on a raft of sods and accompanied by his mother in an iron bowl. The interesting description given in chapter iv of the Danish boat found in 1863 at Nydam in Schleswig indicates not only work which must have been the product of centuries of experience but also a style so different from that of any known Roman ship that her builders must have been working on an entirely separate line of development.

The claim made on behalf of Alfred the Great to be the "Father of the English Navy" is shown to be mainly due not to the fact that he was the first king to own warships but to the circumstance that the vessels of Viking type which he had were rendered the more efficient by improvements devised by him, were bigger and swifter than others, and were used with greater effect in the attempt to attack the enemy at sea as well as to defeat their attempts at landing on his coasts.

The chapter on "The last days of the Sailing Ship" is one of the most interesting in the whole book, and shows the growing variations in construction due to the special commercial needs of new developments occasioned by the discovery of gold in California and Australia and by the opening up of new Chinese ports to foreign trade. Perhaps the most entertaining pages, however, are those which give, with an added modern rendering, a poem that has been preserved in a fifteenth-century MSS in the Library of Trinity College, Cambridge. It deals with the experiences of travellers setting sail from some seaport of the day, the trials with which they had to put up, and the way in which the vessel was handled by master and crew. The details are told with such vividness and

humour, and there is such an atmosphere of the sea and the English sailor about it all, that it seems almost impossible that the scenes and incidents described are those of five or six hundred years ago.

The book is illustrated by a number of excellent plates, together with many woodcuts in the text. Some of the latter, however, are aggravatingly small and indistinct in detail, partly due to the drawing and partly to the character of the paper on which they are reproduced. In the case, for instance, of the important Winchelsea seal—which the present writer has quite recently examined—little idea is given of the great beauty and clearness of the original. There is an excellent index. W. W.

ANSON'S VOYAGE ROUND THE WORLD. By RICHARD WALTER. A new edition, with Prefatory Notes by G. S. LAIRD CLOWES. *London: Martin Hopkinson Ltd.* 1928. 10×6 *inches;* lxiv+402 *pages; charts and illustrations.* £1 11*s* 6*d*

The printing and illustration of this edition are excellent. So also are the footnotes in which the editor explains the technical and obsolete terms with which the narrative abounds. The Prefatory Notes give short lives of Anson and of those of his officers who subsequently rose to fame, a number which included Sir Charles Saunders (Wolfe's colleague at Quebec), Philip Saumarez, Sir Piercy Brett, Lord Keppel, and Lord Howe; good descriptions of the ships engaged in and against the expedition, both Spanish and English (with contemporary drawings and statistics from MSS in the Admiralty Library); and some remarks upon the epidemics which nearly destroyed the undertaking.

So far good, but we ought surely to be given something more than these notes. Anson's voyage was an important historical transaction, and Walter's account of it needs an Introduction which the present editor has not attempted. We need to know the political or strategic objects of the venture, whether it was merely sent forth for the plunder which it actually achieved, or whether it was to spy out the land for English settlement in the unoccupied south of Chile, to gain the information which would facilitate the opening of English trade in the Pacific, to stir up a revolt among the Spanish colonists, or to conquer the West Coast outright. Walter lets fall hints on these matters, but he had to be reticent, for the war was still in progress at the time of his writing. There should be materials accessible to modern research. An obviously important document would be the instructions with which Anson sailed. Mr. Laird Clowes says nothing about them, and leaves us in doubt whether or not they exist. J. A. W.

AN INTERMEDIATE COMMERCIAL GEOGRAPHY. Part II. The Economic Geography of the Leading Countries. By L. D. STAMP. *London: Longmans, Green & Co. Ltd.* 1928. 9×6 *inches;* xvi+263–778 *pages; maps and diagrams.* 12*s* 6*d*

Part I of this work was reviewed in the *Journal* for July 1928 (vol. 52, p. 85), and much of what was said there applies to Part II. This volume is quite as full of statements of fact. It may be of interest to note that the study of natural regions which forms so valuable a feature of Part I is here continued for separate continents and for some countries; but it is difficult to see why the account of natural regions of some countries should follow that of their economic geography (*e.g.* Holland and Belgium, Spain and Portugal), while in other cases the more usual order is adopted. The book has already taken its place as a standard work for the students for whom it was intended. It has a full index to both parts, which helps reference; but it may be suggested that a fairly full analytic table of contents, and corresponding page headings, in place of the six bald chapter headings which are used here, would make it easier to find any desired section.

C. B. F.

THE MONTHLY RECORD

THE OXFORD UNIVERSITY EXPLORATION CLUB

The first report of this young club is a striking document, full of promise for a distinguished future. A club founded in December 1927 launched on 30 May 1928 an expedition to West Greenland of eight members, which took away so large a part of the total membership that the serious organization of the club was delayed until the Michaelmas Term of that year. This year they are sending a party of eleven or twelve to British Guiana, and talk of Cyprus next year and archaeology as a change from ecology. The work of 1928 was a sequel to the three Oxford expeditions to Spitsbergen, continuing in Greenland those studies of the distribution of animal and plant life in which biology and geography are partners indispensable one to the other. The brief account of the expedition by Dr. Longstaff in the present number of the *Journal* makes it unnecessary for us to summarize the clear and well-considered notice that forms the bulk of the report. But we may call attention to a rare and valuable feature: the complete statement of cost, including a loss of eightpence on exchange. The eight members contributed between them about £281 from their own pockets, obtained subscriptions of £105 from friends and £50 from the University Chest. They valued gifts in kind at £52 10*s*. and borrowed equipment to the value of £75. A couple of despatches to *The Times* brought them only the disappointing sum of £15 5*s*. The total cost of £467 for eight persons absent from these shores for ten and a half weeks comes to £5 10*s*. a head per week, nearly two-thirds of this being passage money. The leader and the quartermaster must share the credit for this most encouraging result. It should do much to stimulate rival enterprise in other Universities.

This year the larger party, under the leadership of Major Hingston, propose to try their hands at establishing an observation post in the canopy of the tropical rain-forest of British Guiana, and a grant from our Society's Expedition Fund will provide a surveyor, from the University of Cambridge, who will fix astronomical positions and do what topography he can in this rather unpromising country. A few of the undergraduate members will have to return to keep the Michaelmas Term, but the others will have about five months in the field, so that already in its second season the Club will escape the facile criticism that not very much exploration can be done in a Long Vacation. We take leave to wish the Oxford University Exploration Club a success commensurate with the promise of its first year, and the flattery of sincere imitation.

MECONOPSIS BAILEYI

At the Chelsea Show of 1926 a superb "blue poppy," *Meconopsis Baileyi*, was shown by Lady Aberconway and the Hon. H. D. McLaren, and then first attracted general notice, though it had received an Award of Merit of the R.H.S. at their fortnightly show of the preceding April 7. In early June of the present year a large bed of the plant has flowered magnificently in Kensington Gardens, within three minutes of the Society's House, and the Director of the Royal Gardens at Kew declares that it grows like a weed, which is very unusual in the beautiful flowers that have come from the Tibetan border: too many of them refuse to grow anywhere but in the Edinburgh Botanic Garden, which has a peculiar way with them. This Meconopsis, unlike most of the Tibetan blue poppies, is apparently perennial in English gardens. Its remarkable colour, sky blue, with a touch of grey and often of lavender, and brilliant golden anthers, demands for it a place to itself, for it wrecks any usual June colour scheme. It bids fair, therefore, to become one of the most conspicuous plants in English

gardens; and since in the rather unscientific, not to say commercial, atmosphere of a Chelsea Show public attention is concentrated on the garden where it is grown in England, or on the firm which exploits the novelty, to the exclusion of any interest in the man who discovered the plant, or succeeded in sending it home, we may do well to remark here that the names which should be associated with this Meconopsis are both well known in our Society. And having for greater security inquired of Major Chipp, Assistant Director of the Royal Gardens, we are able to give from his reply the following facts: In the Kew Bulletin for 1915 Sir David Prain described several new species of *Meconopsis*. One of them, of which he had only a fragmentary dried specimen, he named after Major F. M. Bailey, our Gold Medallist of 1916, who had collected it in the Rong Chu valley at Lunang, 10,500 feet above sea, where it was in flower on 10 July 1913. This happened on Major Bailey's well-known journey with Major Morshead to the gorge of the Tsangpo. In his paper describing the journey and published in the *Journal* in October 1914, Major Bailey's only reference to the poppy is in the following passage (p. 347): "Just beyond Trulung we left the Po Tsangpo and ascended the valley of the Rong Chu, up which we marched three days to Lunang, the first village which we reached in the province of Kongbo. The road was through pretty scenery, with clearings in the forest covered in flowers, among which we noticed blue poppies, purple iris, many varieties of primula, and the poisonous aconite."

In 1924 Mr. Kingdon Ward and Earl Cawdor set out to explore the remaining gap in our knowledge of the Tsangpo gorge, and found the blue poppy again in the same locality, about 20 miles north-west of the great mountain Namcha Barwa. Mr. Kingdon Ward's primary objects being botanical, he was prepared to stay in the country until seeds were ripe, and among the rich collection which he sent home to the enthusiastic gardeners who had helped to finance his expedition was the seed of *Meconopsis Baileyi*. It was raised in 1925, flowered in 1926, and proved so easy to grow and so striking a success that by 1929 it had become the most famous of recent introductions.

Although Mr. Kingdon Ward makes no reference to this poppy in his account of the expedition printed in the February number of the *Journal*, 1926, Sir David Prain's remarks (p. 120) in the discussion following the paper read at the evening meeting of the Society, 25 May 1925, show that Mr. Kingdon Ward then spoke of certain mountain poppies which his party had collected. The following description of *Meconopsis Baileyi* appears in Mr. Kingdon Ward's book "The Riddle of the Tsangpo Gorges" (pp. 75–76):

"Beautiful as were the meadows of the *rong*, a patchwork of colour exhaling fragrance, nevertheless the finest flowers hid themselves modestly under the bushes, along the banks of the stream. Here amongst spiteful spiny thickets of Hippophae, barberry, and rose, grew that lovely poppy-wort, *Meconopsis Baileyi*, the woodland blue poppy. This fine plant grows in clumps, half a dozen leafy stems rising from the perennial rootstock to a height of 4 feet. The flowers flutter out from amongst the sea-green leaves like blue-and-gold butterflies; each is borne singly on a pedicel, the plant carrying half a dozen nodding, incredibly blue 4-petalled flowers, with a wad of golden anthers in the centre. The foliage is startling enough, the lower stalked leaves reaching a length of 2 feet, the upper ones sessile, their round-eared bases clasping the stem. Never have I seen a blue poppy which held out such high hopes of being hardy, and of easy cultivation in Britain. Being a woodland plant, it will suffer less from the tricks of our uncertain climate; coming from a moderate elevation, it is accustomed to that featureless average of weather which we know so well how to provide for it; and being perennial, it will not exasperate gardeners.

If it comes easily from self-sown seed, as a few species do, it will be perfect. Unfortunately, like the majority of its kind, it has no scent. It may be remarked in passing that the only known species of Meconopsis which bears any close resemblance to *M. Baileyi* are the Chinese *M. betonicifolia* and the Bhutanese *M. superba*."

This last statement is interesting in view of the fact that Major Chipp points out that systematic botanists, including Sir David Prain, are now coming to the conclusion that the plant is probably only a geographical form of *M. betonicifolia*. It is also interesting to see how accurate has proved Mr. Kingdon Ward's estimate of the adaptability of this plant to the English climate.

CHANGES OF NAMES IN CHINA

It is reported that the National Government in China has issued mandates altering the name of Peking to Peiping (also spelt Peping), Chihli (province) to Hopei, and Fengtien (province) to Liaoning. Peiping (Wade, Peip'ing), which means "Northern Plain," not "Northern Peace" as some have assumed, was an old name derived from a saying of Confucius and used for a time during the Yuan dynasty founded by Kublai Khan, who, however, called the city Khan Balik (whence Cambaluc). The change of Chihli to Hopei, meaning "North of the River," will hardly be welcomed by westerners, as there is already a province named Hupeh. It is only about a decade since the Manchurian province now named Liaoning, meaning "The Liao (river-name) Peace," was known as Shengking. Fengtien used to be the Chinese name of Moukden; but we are informed that according to the local press this place is to revert to its original name, Shenyang. The Gulf and Straits of Chihli are to be known in future as the Gulf and Straits of Pohai.

TRONDHJEM, OR NIDAROS

The recent resolution of the Norwegian Lagting to alter from January 1 next the name of Trondhjem to Nidaros, which is said to have been carried by only a small majority and not entirely with the consent of the citizens, is yet another instance of the *cacoethes mutandi* that seems to be plaguing the world at the present time in the matter of place-names. The desire to get rid of appellations like Kristiania and Fredrikshald that smacked of Danish domination was intelligible. There is no such flavour in the word Trondhjem; but the fact that it supplanted the old name of Nidaros about the middle of the sixteenth century when Norway was losing her last shred of independence to Denmark may make it unpalatable to super-ardent patriots. However, if the inhabitants of the place itself are really against the change, they may prevail on the Government to revoke the decision before 1930. The revived name, pronounced Nídarōs, is the Niðarós (*scotice* Nidoyce, *anglice* Nidmouth) of the Heimskringla. The town was founded by Olaf Tryggvason in 996. Thrandheim (Þrandheimr) at that time denoted the region round the fjord. The name Trondhjem, therefore, was not an invention of the sixteenth century, but was a district name revived and given to the town for reasons that are obscure.

'THE CENTRAL AMERICANS': A CORRECTION

In a review of 'The Central Americans' by Arthur Ruhl, published in the May *Journal*, Mr. Ruhl is designated a "careless observer" because he remarks that there is "nothing to see" in San José de Costa Rica, "neither museums, nor antiquities nor architecture." Thomas Barcourt, Professor of Zoology and Director of Harvard University Museum, has written pointing out that the reviewer is evidently unaware that since the last earthquake some years ago the museum cited in the review has been a dilapidated wreck, closed to the public

and, for lack of funds, without any promise of ever being rehabilitated. The building leaks, the roof is but part of a roof, and the valuable material is in hopeless confusion and covered with dust. For this, Professor Barcourt writes, no one is to blame and no one feels the tragedy of the situation more keenly than those cultured citizens of San José who are interested in their country's art and archaeology. Professor Barcourt adds that he has not seen the collection of gold ornaments, mentioned in the review, for very many years. We regret that our reviewer was not better informed of present conditions in San José de Costa Rica.

THE AUSTRALIAN ANTARCTIC RESEARCH EXPEDITION

The Prime Minister of the Commonwealth has recently made in the Australian Parliament the following statement:

"Having given the closest and fullest consideration to the question for several years past, the Commonwealth Government has reached the conclusion that the time is now ripe for an Australian expedition to proceed to that part of the Antarctic which lies immediately to the south of Australia. It has therefore decided to organize and equip such an expedition, which, it is at present contemplated, will leave Australia towards the end of this year. In view of his great experience and knowledge of Antarctic conditions, and his world-wide reputation in scientific circles, we have approached Sir Douglas Mawson and asked him to lead the expedition. Sir Douglas has informed us that he will be prepared to do so. The special interest of the Commonwealth in the Antarctic region lying south of Australia, extending from the Ross Sea in the east to Enderby Land in the west, which is generally known as the Australian sector, has been often affirmed in the past. Of the various expeditions to this region, the richest so far in scientific and other achievement was Sir Douglas Mawson's expedition of 1911–14. The expedition that the Commonwealth Government has decided to organize this year will, it is hoped, complete and crown this previous Australian effort.

"His Majesty's Government in Great Britain has generously placed the *Discovery* at the disposal of the expedition, free of charge. This vessel is at present in the service of the Falkland Islands Dependencies, and has been specially constructed for work in the ice. It is the best ship at present afloat for the purposes of the expedition.

"The forthcoming expedition will seek to effect a variety of objects, mostly of a scientific nature. The exploration and mapping out of that part of the coast-line which could not be completed by the Mawson expedition in 1911 will be undertaken, scientific and meteorological work will be carried out, investigations into the economic resources of the region will be made.

"The exact location of the coast-line of this sector of the Antarctic in which Australia is interested is of material importance. The expedition will therefore carry out hydrographic survey work, comprising the correct location and charting of coasts, islands, rocks, and shoals. It is proposed to equip the expedition with aeroplanes so that inland surveys can be made. The study of meteorological conditions which will be made will enable the relationship between these conditions and the climate and weather of Australia to be determined more adequately than at present. A further important part of the expedition's work will be to carry out investigations regarding the fauna, notably whales and seals, of the region explored. Whaling in various parts of the Antarctic, notably south of the Falkland Islands, New Zealand, and South Africa, has now assumed considerable importance, and the Government feels that it is most desirable that investigations should be made in the near future to determine the

economic and commercial value of the waters of the Australian sector in this respect."

Sir Douglas Mawson, who was for some months in this country on the business of the expedition, has now returned to Australia, leaving Captain J. K. Davis to take out the *Discovery* in August next. We understand that the ship is lent to the Australian by the British Government, who have rented her from the Falkland Islands Government, and that a new and larger ship is now being built for the research work of the Falkland Islands Dependencies.

NEW ANTARCTIC CHARTS

The American Geographical Society of New York has recently brought out a large chart of the whole of the Antarctic Regions south of latitude 63°, which should be very useful for general reference, especially at the present time when there is a renewed interest in the exploration of that still little-known part of the world. The chart is in four sheets, each measuring about 30 × 30 inches, and the whole region is represented within a circle of 58·8 inches in diameter. It is drawn on the stereographic projection, the scale on the parallel of 71° being 1/4,000,000 (or 1 inch to 63·1 stat. miles). Water is in blue, but the rest of the chart is printed in black only. Where any information is available on the land a general idea of the relief is given by approximate contours at intervals of 200, 500, 1000, and 2000 metres. Depths of the surrounding ocean are shown by figures, and approximate contours at the same intervals as the land heights.

The compilation of the chart has entailed considerable study of the work done by early and more recent Antarctic expeditions, the results of which are clearly shown, although no actual routes are laid down. The lines of equal magnetic variation for every 10° are given, and brought up to 1927. The chart can be mounted together as one if desired; but each sheet is complete in itself and contains title, scale, explanation of symbols and general reference. On each sheet too is a diagram showing graphically, by means of wind-roses, the direction and velocity of the wind for certain stated months and years at some special locality. There is room for improvement in the lettering, and some of the names are so awkwardly placed that it is difficult to see to what they really refer. Then again, it would have been well if the names themselves had been more carefully revised, as some are wrongly spelt. For instance, C. Wadsworth should be C. Wadworth; Mt. Kilpatrick, Mt. Kirkpatrick; Mt. Aldwich, Mt. Aldrich; and C. Selborn, C. Selborne. Other similar cases could be mentioned. Still, taken as a whole this is a really good chart, and it cannot fail to be of considerable service to all who are interested in the Antarctic Regions.

In addition to this large-scale four-sheet chart the American Geographical Society has published a smaller one on one sheet, measuring 20¼ × 20¼ inches. This is an outline printed in buff, with only a few names, but with the graticule and lines of equal magnetic variation well shown. It is intended for use in aerial navigation, and an explanation is given in a pamphlet which accompanies the two charts.

THE CLIMATE OF NOVAYA ZEMLYA

On the basis of observations taken by the various expeditions to this region and of the more continuous observations at fixed Russian stations in recent years an interesting account of the climate of Novaya Zemlya is given by O. Edlund ('Report of the Scientific Results of the Norwegian Expedition to Novaya Zemlya, 1921,' edited by Olaf Holtedahl, vol. 2, No. 39: "Übersicht über das Klima von Nowaja Semlja"). Like all Arctic lands Novaya Zemlya is in some sense under conditions of glaciation, since an extensive ice-sheet and

snowfield occupies the interior of the south island, reaching to a height of about 3000 feet. Level for level the climate is more rigorous than, at any rate, the west coast of Spitsbergen. The mean February temperature at Karmakuli on the south-western coast (or the warmer side of the island) is given as 3° F., the mean July as 43·5° F., and the mean annual as 21° F. The absolute minimum recorded anywhere in the island is −39° F. in January, and the absolute maximum 72° F. in July. In no summer month has the temperature failed to pass slightly below the freezing-point, and in no winter month has it failed to rise slightly above it. In the latter connection it may be pointed out that on the west coast of Spitsbergen the temperature occasionally exceeds 40° F. in the depth of winter, with the accompaniment of rain, when a long-distance southerly air-current has managed to follow the warm water. As in all polar lands fog is a feature of summer rather than of winter. Precipitation is only some 12 inches in the year, 75 per cent. of it being in the form of snow, which falls even in the height of summer. The climate of the islands is naturally much influenced by the quantity and distribution of the sea-ice, which is said to affect the course of cyclonic depressions. When there is much ice in the vicinity the winters are very cold and summers foggy, but when there is little ice the winters are milder but very snowy, and the summers relatively warm and dry.

Outflowing winds are referred to as occurring in very cold weather, but nothing analogous to the centrifugal blizzard winds observed by Mr. K. S. Sandford in North-East Land (*Journal*, 68, 200) is mentioned. A feature discussed at some length, however, is a stormy land-wind known as the *Bora*, named after the well-known Mediterranean local storm wind. This pours down the mountainous defiles in certain types of weather and is dangerous to ships in the vicinity. It is not a local wind, but a general cyclonic wind accentuated by local configuration. (It must be remembered that all "general" winds are subject to local modification through geographical detail, and that even so-called "local" winds are always conditioned by the general meteorological situation.)

In the first number of the same volume the editor, O. Holtedahl, contributes a paper on the rocks of Novaya Zemlya largely in relation to the geological history of the island. In this he enters into the question of the past climate of Novaya Zemlya, and criticizes a view attributed many years ago to Prof. J. W. Gregory, that the subtropical or tropical fossils discovered here were dwarfed forms and therefore no proof of a warm climate in bygone ages.

THE WEST INDIES HURRICANE OF SEPTEMBER 1928

The hurricane which devastated the West Indies and Florida between 10 and 20 September 1928, in the height of the hurricane season, is regarded, according to a report on the storm by C. L. Mitchell in the *Monthly Weather Review* for September 1928, as nearly, if not quite, the most violent of which there is any record. It appears to have first taken shape near the Cape Verde Islands on September 10, and to have finally lost energy and merged in an extra-tropical cyclone in Ontario, Canada, on the 20th. Along this curved track the islands most severely visited, together with Florida, were Guadeloupe, Porto Rico, St. Kitts, and Montserrat. In the Florida peninsula nearly 2000 persons were drowned in consequence of the overflowing of Lake Okeechobee, whilst in Porto Rico (concerning which a special report appears by O. L. Fassig) there were 300 persons killed and several hundred thousand rendered homeless. The vortex travelled forward at the usual slow rate of about 14 miles per hour, but the speed of the wind in it is estimated at many places to have been upwards of 150 miles per hour. The barometer dropped within a few hours from normal levels to the vicinity of 27·5 inches, and as speedily recovered. The greatest

amount of rain occurred in the Loquillo Mountains of Porto Rico, where over 25 inches fell in twenty-four hours. In Porto Rico, over which the storm passed on the 13th, it is known as the " San Felipe II.," it being the custom in that island to label notable hurricanes after the saints' days on which they occur. The "San Felipe I." occurred in 1876, but the only storm comparable with that of 1928 was "San Ciriaco " of 8 August 1899, which took an almost identical path across Porto Rico, and caused 3000 deaths, mainly through floods. In the storm under discussion winds of hurricane force were experienced for as long a period as twelve hours in the various affected places. Owing to the close watch over the situation kept by the United States Weather Bureau, which issued insistent warnings to vessels, the loss of life at sea was fortunately slight.

Although still more violent winds may occur in tornadoes, these are so small and shortlived as to be not comparable with a bad tropical cyclone such as that here in question. During the very period that this was raging in the West Indies, exceptionally severe tornadoes, taking toll of several lives, developed in Missouri and Illinois, and accounts of these are given in the same number of the *Monthly Weather Review* by G. K. Greening and F. M. Week.

QUATERNARY CHANGES OF SEA AND LAND LEVELS

Mr. Ernst Antevs, whose important memoir on the last glaciation was reviewed in the *Journal* for December 1928 (p. 564), sums up our knowledge of the Quaternary marine terraces on both sides of the North Atlantic, and the changes in sea and land-levels deducible therefrom, in the *American Journal of Science* for January of this year. The terraces considered are outside the areas covered by the Quaternary ice-sheets and differ from the terraces associated with the latter in their horizontality. On the American side of the Atlantic they occur on the east coast of the United States from New Jersey to Florida, and also on the north coast of the Gulf of Mexico, and on the opposite side are found nearly all round the Western Mediterranean, while a series of river-terraces closely agreeing with the above is to be seen on the Euphrates between Raqqa and Deir ez Zor. In these widely separated regions there is a general agreement in altitude between the corresponding units of the several series, those of the same altitude in the different localities being apparently of the same age. Mr. Antevs discusses the various possible explanations of these facts on the basis of crustal movements together with fluctuations of sea-level due to change in the relation of water and ice on the face of the globe. (He calculates that the melting of existing ice-sheets would raise the general sea-level 130 to 200 feet.) The conclusions reached (which some will no doubt think open to question) are as follows: The terraces are of marine origin and seem to date from the pre-glacial and three interglacial periods, and to be correlated with one another. The coastal region south of C. Hatteras has risen since the second interglacial by practically the same amount as the Mediterranean region, and before the same period by a lesser amount, these movements being ascribed to the effect of erosion. On the other hand, the sea-surface appears to have suffered a progressive lowering, apart from fluctuations due to change in the relations of water and ice, by reason (in Mr. Antevs' view) of a sinking of the ocean floor. The agreement in the amount of uplift since the second interglacial suggests a similar amount of erosion and sensitive equilibrium of the Earth's crust. The fact that ever since pre-glacial time the North American east coast has stood lower than to-day (which seems to be true also of Norway since the first interglacial) shows that the glaciations cannot have been directly due to high stand of the continents.

TECTONICS OF INTRUSIONS

A detailed tectonic and petrographical examination of the granitic intrusions of the Southern Schwarzwald has led Dr. S. von Bubnoff ('Der Werdegang einer Eruptivmasse,' Berlin; Borntraeger 1928) to conclusions which are of more than local interest. During the Variscan period of mountain-building the pre-existing gneissic block of the Southern Schwarzwald was pushed against a trough of more yielding material which lay to the south, and this movement was accompanied by deep-seated granitic intrusions. There was some overthrusting, but nothing comparable in magnitude or extent with the overthrusting along the northern margin of the Variscan range, and the disturbance did not extend eastward into the area which is now covered by later beds. The movement of the gneissic mass was associated with the formation of planes of disruption, and it is along these planes that the intrusions took place. There can be little doubt that the magma of the intrusions was formed by the melting of the base of the gneiss, but it is not yet possible to determine whether the intrusion of the magma was the cause or the consequence of the movement of the block.

AN IPSWICH MERCHANT WHO SAILED WITH CAVENDISH

The January 1929 number of the *Mariner's Mirror* contains some interesting notes by Mr. A. D. Harrison on the Ipswich merchant Thomas Eldred, member of an important East Anglian family, who made the voyage round the globe in 1586–88 with Thomas Cavendish. The fact that he did so is known from a statement under date 1600 in the Court Records of the East India Company, and also from the inscriptions on two sets of paintings still preserved, which give the dates of his departure and return to Plymouth, though without mentioning Cavendish's name. There are three paintings on panels in each case, one set being now at Ipswich in the residence of Mr. J. D. Cobbold, the other (which is reproduced in facsimile with the article) at the Manor of Olivers in Essex, a property purchased by Thomas Eldred's son John. In each set there is a portrait of the merchant, who is shown as a fairly young man in the Ipswich set, but as an old man in the other. The other two paintings are in each case a ship and a globe, the ship being shown in elaborate detail at Olivers, and thus presenting an interesting record, though perhaps not so like Cavendish's ship as the earlier one. Mr. Harrison brings together from the Ipswich records a number of references to the merchant (or to a contemporary of the same name, for there was a succession of Thomas Eldreds of Ipswich), who for some years was one of the two "Common Chandlers" under bond to supply candles to the inhabitants. The East India Company records show that there was some talk of employing him as Captain or Master of one of the ships on the first voyage to the East, but he did not go, possibly because of his age, he being then well over sixty. He must however have shown some qualifications as a navigator. He must not be confused with John Eldred, the merchant-traveller to Tripoli and the East, whose journeys are recorded by Hakluyt, and there is no proved relationship between them, though Thomas was recommended to the East India Company by John, so that they were at least acquaintances.

OBITUARY

COLONEL E. LESTER JONES

The many friends whom he made when he came last summer to the Geographical Congress will have been shocked to hear of the untimely death of Colonel Lester Jones, Director of the United States Coast and Geodetic Survey,

at the early age of fifty-three, after fourteen years' tenure of that important office. He made no claim for himself to scientific distinction; but that he was a most capable director is evident from the recent history of the great organization which he controlled. The output of its scientific divisions has been immense: we look with respectful admiration and a little envy on a department of the public service which can command twenty mathematicians, and realize that even in the United States of America it can be no easy task to obtain the increasing appropriations necessary to support geodetic and hydrographic survey on such a scale. The Director who can take upon his shoulders all the cares of organization and supply, leaving the chiefs of his scientific divisions unfettered freedom to pursue their technical work, does great service to science; and this Colonel Lester Jones performed. Moreover, he was always ready to be helpful to others; he took much trouble to procure for the Society a portable tide-gauge of the U.S.C.G.S. pattern which was wanted in a hurry for the use of our geographers attached to the Great Barrier Reef Expedition, and to answer questions on an interesting point of International Boundary practice. His impressive courtesy as a delegate and kindness of heart as a colleague will be long remembered.

MEETINGS: SESSION 1928–1929

Fourteenth Evening Meeting, 27 May 1929. The President in the Chair.

Elections: Harry Bates, A.V.C.M.; William Belcher; Norman Charles Brooks, B.A.; Miss Winifred M. Clinch; Francis James Crossland, B.SC.; Frank Dexter; Fred. I. Dexter; Bernard Dunning; Leslie Ashcroft Ellwood; The Rev. Kenneth Macfarlane Harley; Miss Ada C. Hay; The Rev. Robert Henry Holmes; Emrys Robert Jenkins; Walter Herbert Oldfield; Miss Beatrice Osmond; Harry Hepburn Reid; Vice-Admiral Sir Hugh Dudley Richards Watson, K.C.B., C.V.O., C.B.E.; Whiting Williams, A.M.

Paper: A Journey in Central Siam. By Mr. L. J. Robbins.

Special General Meeting for the Revision of the Bye-Laws, 3 June 1929. The President in the Chair.

140 Fellows were present, and the changes in the Bye-Laws proposed by the Council, with some slight amendments, were adopted.

Fifteenth Evening Meeting, 10 June 1929. The President in the Chair.

Elections: Sirisena Wijayatilaka Atukorala; Capt. Wilfrid John Croker Wilson Barrow; C. C. Bayzand; Capt. the Hon. Bede Edmund Hugh Clifford, C.M.S., M.V.O.; Frederick Hurn Constable, M.A., D.SC., PH.D.; Kenneth C. Edwards, B.A.; General Paulo Emilio Escobar; Prof. Alfred John Gould; The Hon. Mrs. Spencer Graves; Raymond Griffith; Lt.-Col. Thomas Hubert Harker, D.S.O.; Miss Evelyn Mary Hart; Walter E. Higham; Prof. Archer Butler Hulbert, M.A., LITT.D.; Mrs. Maud L. Jones; H. G. Keith, B.SC.; Lieut. R. B. Littledale; Henry Joseph Marshall McFall; William Martin, B.SC., Mrs. Ethel Maud Martley; James Muirhead, A.M.I.C.E., A.M.I.W.E.; Richard Edward Nation, M.A.; Mrs. Sarah E. Linton Neligan; Miss Florence Robinson, M.A.; J. C. W. Rutherfoord; Col. Christopher Thomas Sennett, F.R.S.A.; Miss Margaret Eleanor Ryder Shipton; Martin Luther Thomas, B.SC.; Miss Edith Thompson, B.A.; Owen Tweedy; Alfred Thomas White; Frank P. Wilson.

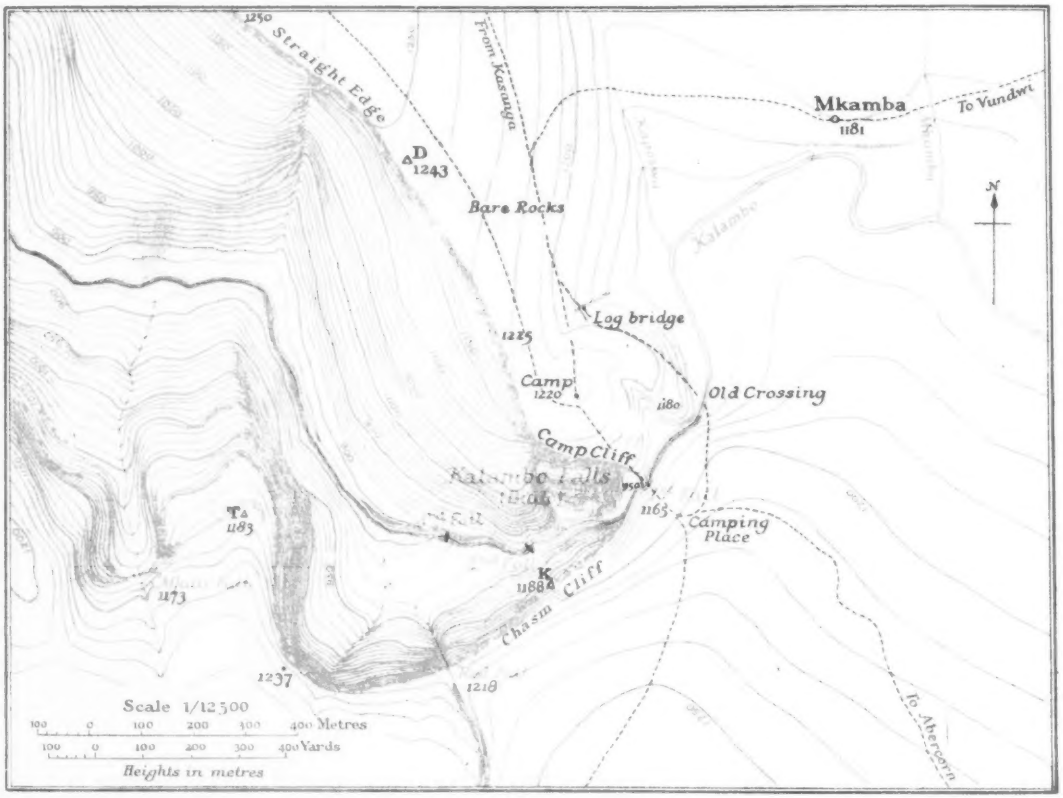
Paper: The Saura Oases and the Niger from Timbuktu to Jebba. By Mr. Leonard T. Scott.

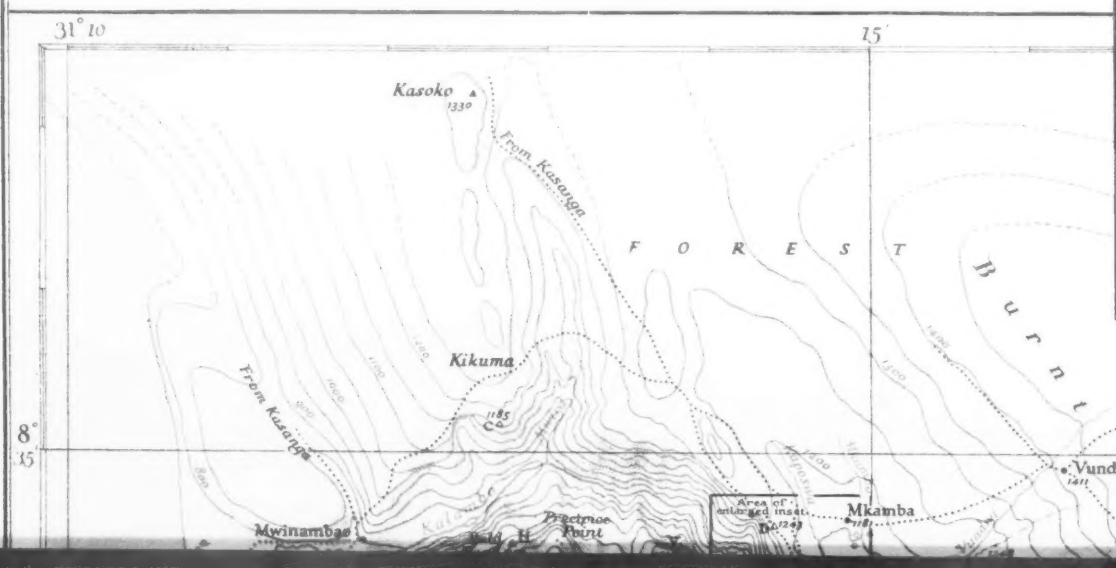
TANGANYIKA TERRITOR

Mrs. E. Gordon-Gallien's Expedition t

KALAMBO FALLS

1928.





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TRIANGULATION CHART

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C
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H
Yellow Knob
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Uyinza
Ujiji
Manyoni
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Dodoma
Mpwapwa
Mhonda
Kilosa
Kitunda
Kareima
Mpimbwe
Kirando
Kipembawe
Iringa
Kiberege
Utete
Mafia
Kate
Kala
Kasanga
Madibira
New Utengule
Malangali
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TANGANYIKA
TERRITORY

GRASS
To Kipoma

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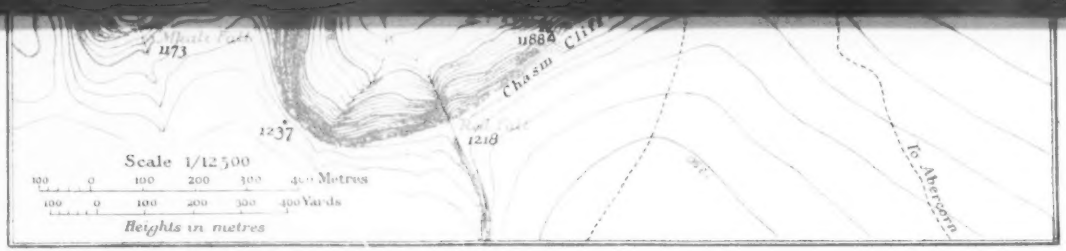
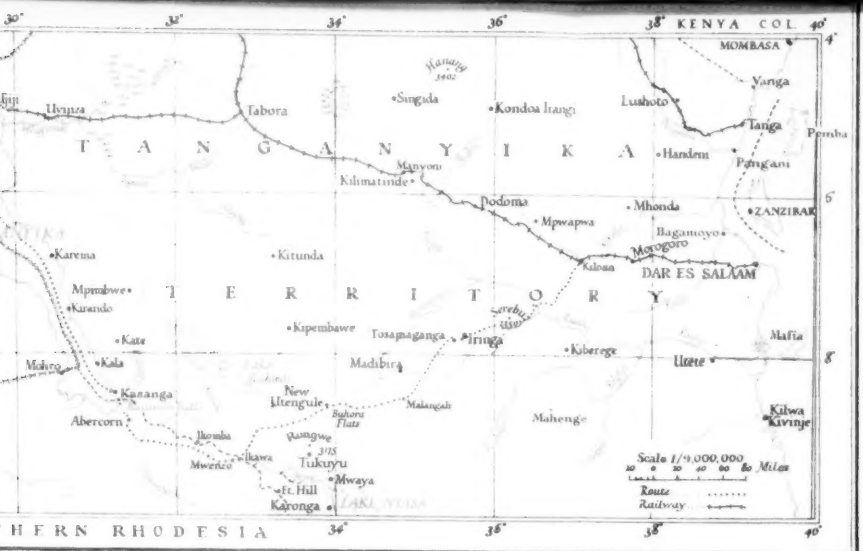
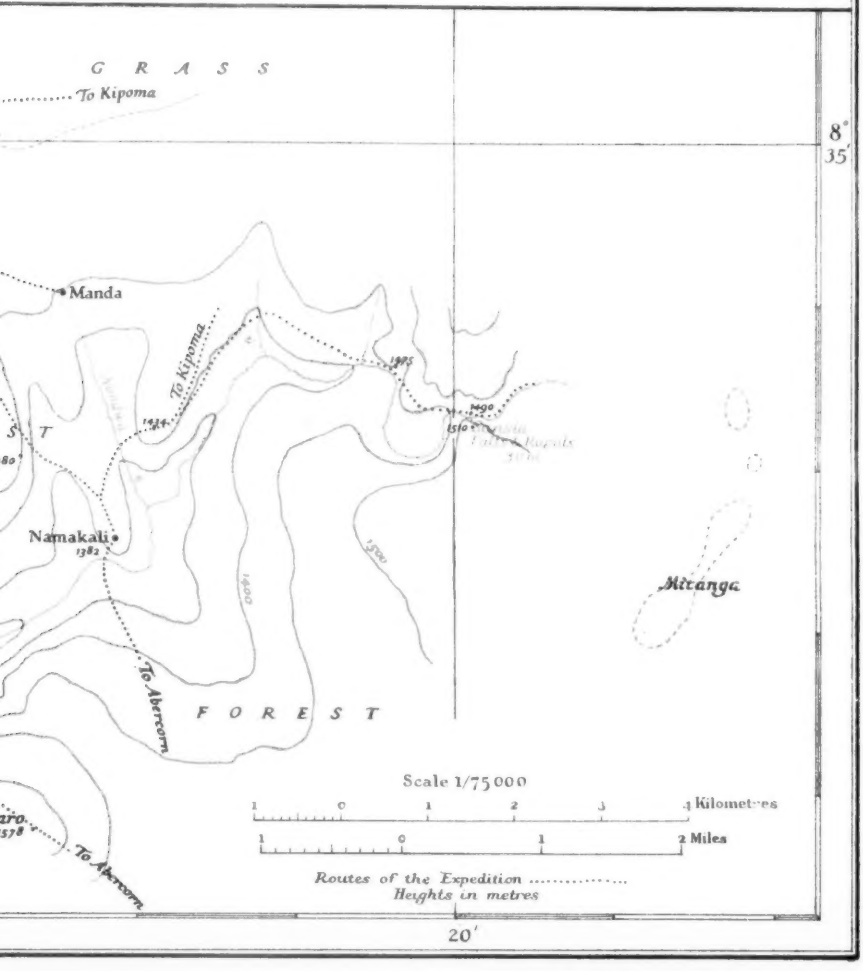


Note

The topography is from a survey with a 1·5 in theodolite and plane table by Lieut. J. W. Cornwall, R. A., of Mrs. Gordon-Gullien's expedition, based upon points (marked A and B) fixed by the triangulation of the Anglo-German Boundary Commission, 1898. Heights, in metres, are from theodolite and clinometer vertical angles. Further particulars will be found in the papers which the map accompanies.

Published by the Royal Geographical Society





KALAMBO FALLS
Gordon-Gallien